U.S. Army Corps of Engineers
New England Division

RESPONSE ACTION OUTCOME NARRATIVE

WESTOVER SURPLUS PUMPHOUSE SITE
Release Tracking Number: **1-0299**

FORMER WESTOVER AIR FORCE BASE
Chicopee, Massachusetts

Prepared under:
Contract No.: DACW33-94-D-0007
Delivery Order 18

Prepared by:
ABB Environmental Services, Inc.

November 1996

Stone & Webster Environmental
Technology & Services

RESPONSE ACTION OUTCOME NARRATIVE

WESTOVER SURPLUS PUMPHOUSE SITE
FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

DERP PROJECT NUMBER: DO1MA000600

MADEP RELEASE TRACKING NUMBER: 1-0299

Prepared for:

Department of the Army
U.S. Corps of Engineers, New England Division
Waltham, Massachusetts

Prepared by:

ABB Environmental Services, Inc.
Portland, Maine

CONTRACT NUMBER:
DACW33-94-D-0007
Delivery Order No. 18

NOVEMBER 1996

RESPONSE ACTION OUTCOME NARRATIVE

WESTOVER SURPLUS PUMPHOUSE SITE
FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

TABLE OF CONTENTS

Section	Title	Page No.
1.0	INTRODUCTION	1-1
1.1	SITE DESCRIPTION AND HISTORY	1-2
1.2	PREVIOUS INVESTIGATIONS	1-2
1.3	DISPOSAL SITE DEFINITION	1-3
2.0	RISK CHARACTERIZATION	2-1
2.1	SITE-SPECIFIC INFORMATION	2-2
2.2	NATURE AND EXTENT OF CONTAMINATION	2-3
2.3	SELECTION OF OHM OF CONCERN	2-5
2.4	RECEPTOR INFORMATION	2-6
2.5	IDENTIFICATION OF EXPOSURE POINTS, EXPOSURE ROUTES, AND EXPOSURE POINT CONCENTRATIONS	2-7
2.6	IDENTIFICATION OF SITE GROUNDWATER AND SOIL CATEGORIES	2-8
2.7	SELECTION OF A METHOD FOR RISK CHARACTERIZATION	2-10
2.8	RISK CHARACTERIZATION RESULTS	2-12
2.8.1	Pumphouse No. 1	2-12
2.8.2	Pumphouse No. 3	2-13
2.8.3	Pumphouse No. 6	2-13
2.8.4	Defueling Area No. 2	2-14
2.8.5	Risk Characterization Conclusions	2-14
2.9	IMMINENT HAZARD EVALUATION	2-15
2.10	CHARACTERIZATION OF RISK TO SAFETY	2-15
3.0	RAO CONCLUSIONS	3-1
3.1	CONCLUSIONS	3-1
3.2	EVALUATION FOR FEASIBILITY OF APPROACHING BACKGROUND	3-2
3.3	ACTIVITY AND USE LIMITATION STATEMENT	3-4
3.4	LSP OPINION AND CERTIFICATION	3-4

TABLE OF CONTENTS
(continued)

Section		Title	Page No.
APPENDICES			
APPENDIX A	-	SUMMARY OF ANALYTES DETECTED IN GROUNDWATER AND SOIL DURING ABB-ES AND GZA INVESTIGATIONS	
APPENDIX B	-	O'REILLY, TALBOT AND OKUN SITE ASSESSMENT DATA FOR PROPERTY TRANSFER TO U.S. TSUBAKI, INC.	
APPENDIX C	-	TIGHE & BOND FIGURES AND TPH DATA FOR WESTOVER INTERCEPTOR SEWER PROJECT	
APPENDIX D	-	FATE AND TRANSPORT MODELLING FOR PLUMES AT FORMER WESTOVER AIR FORCE BASE	
APPENDIX E	-	HUMAN HEALTH RISK CALCULATIONS FOR SURFACE WATER AND SEDIMENT	
APPENDIX F	-	DERIVATION OF METHOD 1 GW-3 STANDARDS FOR METHOD 2 RISK ASSESSMENT	

RESPONSE ACTION OUTCOME NARRATIVE

WESTOVER SURPLUS PUMPHOUSE SITE
FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LIST OF FIGURES

Figure	Title
1-1	Westover Surplus Pumphouse Site No. 1-0299
1-2	Pumphouse No. 1 - Disposal Site Boundary
1-3	Pumphouse No. 3 - Disposal Site Boundary
1-4	Pumphouse No. 6 - Disposal Site Boundary
1-5	Defueling Area No. 2 - Disposal Site Boundary

RESPONSE ACTION OUTCOME NARRATIVE

WESTOVER SURPLUS PUMPHOUSE SITE
FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LIST OF TABLES

Table	Title
2-1	Potential Exposure Pathways
2-2	Method 2 Risk Characterization for Soil - Pumphouse No. 1
2-3	Method 2 Risk Characterization for Groundwater - Pumphouse No. 1
2-4	Method 2 Risk Characterization for Soil - Pumphouse No. 3
2-5	Method 2 Risk Characterization for Groundwater - Pumphouse No. 3
2-6	Method 2 Risk Characterization for Soil - Pumphouse No. 6
2-7	Method 2 Risk Characterization for Groundwater - Pumphouse No. 6
2-8	Method 2 Risk Characterization for Soil - Defueling Area No. 2
2-9	Method 2 Risk Characterization for Groundwater - Defueling Area No. 2

1.0 INTRODUCTION

This document presents the results of the risk characterization for the Former Pumphouse site at the former Westover Air Force Base (AFB) in Chicopee, Massachusetts, and was completed in accordance with the Risk Characterization Scope of Work submitted to the U.S. Army Corps of Engineers, New England Division (NED) on February 16, 1996. This report incorporates comments on the scope of work received from the Massachusetts Department of Environmental Protection (MADEP) in a letter dated March 6, 1996. The risk characterization addresses the sites of four former storage areas, Pumphouses Nos. 1, 3, and 6, and Defueling Area No. 2 which, along with Pumphouse No. 2, comprise the Westover Surplus Pumphouse site, Release Tracking Number (RTN) 1-0299. The Westover Surplus Pumphouse site is currently a Tier 1A classified site and was originally placed on the Transition Sites List in 1993. As part of a separate response action, the NED is concurrently preparing Release Abatement Measure (RAM) plans at Pumphouse No. 2 and the Lonczak Drive Area (LDA) (RTN 1-1011) under this contract, to address residual source area contamination and floating product. For these two areas, an investigation has been conducted and is being reviewed to determine whether remedial action is necessary. Risk assessments will be done following the completion of this review or the remedial action, if one is deemed necessary. The risk characterization for the four sites addressed in this report have been performed based on data collected from 1988 through 1996. The risk characterizations for Pumphouses Nos. 1 and 3 and Defueling Area No. 2 will document whether conditions are suitable for achieving Class B-1 Response Action Outcomes (RAOs) pursuant to the Massachusetts Contingency Plan (MCP; 310 CMR 40.0000). Class B-1 RAOs are applicable to disposal sites when remedial actions have not been conducted because a level of No Significant Risk exists and no Activity and Use Limitation (AUL) is necessary to ensure the existence or maintenance of a level of No Significant Risk (MCP; 310 CMR 40:1046). Remediation activity has occurred at Pumphouse No. 6, making it ineligible for a Class B-1 RAO. Pumphouse No. 6 will be evaluated to document whether it has achieved a Class A-2 RAO. Class A-2 RAOs apply to sites when a permanent solution has been achieved, OHM are not reduced to background, and no AUL is necessary to maintain a level of No Significant Risk (MCP; 310 CMR 40: 1036). RAO Statement forms are filed together with this report.

The Massachusetts Contingency Plan (MCP) requires completion of a public health and environmental risk characterization as part of an MCP Site Investigation (310 CMR 40.0835 (4)(g) and (h)). To comply with these requirements, ABB Environmental Services (ABB-ES) and Stone & Webster Environmental Technology & Services have completed a baseline public health and environmental risk characterization to estimate the impact that oil or

hazardous material (OHM) may have on human and ecological receptors at the study areas and in the surrounding environment. This assessment includes a qualitative evaluation of the risk of harm to safety. The evaluation characterizes risks to identified receptors under current and reasonably foreseeable site activities and uses.

1.1 SITE DESCRIPTION AND HISTORY

The Westover Surplus Pumphouse site is located in an industrial park in the southwestern portion of the former Westover AFB, and is part of Westover Metropolitan Development Corporation's (WMDC) Airpark-West, an industrial park. WMDC was incorporated in 1974 by the Commonwealth of Massachusetts to promote and develop for industrial use a portion of the former Westover AFB property. Since 1974, WMDC has acquired additional acreage, and portions of the property, including the original 221 acres, have been sold to be developed by industrial owners. The pumphouse areas and Defueling Area No. 2 lie within an approximately 200-acre portion of Airpark-West which includes former base structures, undeveloped land, and commercial and industrial facilities constructed since 1974. Airpark-West is bounded by Westover Metropolitan Airport facilities to the south and southeast, an active portion of Westover AFB to the east and north, and a mixed residential and commercial neighborhood to the northwest and west.

From 1940 to 1955, the base served as a port of embarkation and debarkation, and as headquarters of the Military Airlift Command. In 1955, it was recommissioned as a major base for the Strategic Air Command. In 1974, the active military base became an Air Force Reserve base with the 439th Tactical Airlift Wing as the major unit. A total of 2,364 acres were retained for use as a reserve base. The remaining area, approximately 221 acres, was conveyed to the General Services Administration on July 31, 1975, and was subsequently transferred to WMDC by deed dated April 4, 1978 (GZA GeoEnvironmental, Inc. [GZA], 1994). The Surplus Pumphouse site is located on properties owned by the WMDC and private owners. Prior to 1939, the site was reportedly farmed, principally for tobacco. In 1939 and 1940, the majority of the land for Westover AFB was acquired by the federal government. Activation of the property as Westover AFB occurred during 1940.

1.2 PREVIOUS INVESTIGATIONS

Information presented in this section was provided in the USACE-NED SOW (1995) and the *Final Phase II Investigation, Former Westover Air Force Base, Chicopee, Massachusetts, Site No. 1-0299* (GZA, 1994).

Under contract with the USACE-NED, GZA completed a Phase II Investigation in accordance with the MCP in 1994 for Pumphouse Areas Nos. 1, 2, 3, and 6, and Defueling Area No. 2 to determine the extent of contamination which resulted from leaking underground jet fuel tanks and lines. The investigation documented JP-4 contamination in soil and groundwater at the five investigated sites. Floating product was observed at Pumphouse No. 2 and further investigation is underway to provide data to support the preparation of a RAM plan. A sixth area, the LDA, was identified as a separate site by GZA and was not included in their investigation.

A Phase I Site Investigation (SI) at the LDA was completed in 1995 by ABB-ES (ABB-ES, 1995a) in accordance with the MCP. Results of the SI field activities and a Licensed Site Professional (LSP) Evaluation Opinion and Tier Classification were submitted with the report. The SI characterized extensive soil and groundwater BTEX contamination at the LDA and confirmed a floating product layer at the water table. A dissolved-phase BTEX plume was also identified downgradient of the LDA. Further investigation is also underway at the LDA to provide data to support the preparation of a RAM plan.

In 1996, O'Reilly, Talbot & Okun performed an investigation for the sale of property to U.S. Tsubaki (O'Reilly, Talbot & Okun, 1996). One well was installed in the area of Pumphouse No. 1. In 1990-91, Tighe & Bond completed an investigation for installation of a new sewer line in the area of Pumphouse No. 6. During the installation of the sewer line approximately 620 tons of contaminated soil were excavated and disposed of off-site (Tighe & Bond, 1991).

1.3 DISPOSAL SITE DEFINITION

Based on the data presented in previous subsections regarding the site history and results of previous investigations, the Disposal Site of Concern for this RAO Statement consists of four of the five areas of soil and groundwater contamination which comprise the Westover Surplus Pumphouse site (RTN 1-0299). The four former storage areas addressed in this RAO are Pumphouses Nos. 1, 3, and 6, and Defueling Area No. 2. The fifth storage area, Pumphouse No. 2, will be addressed in a future RAO Statement after investigative activities and remediation, if necessary, are completed. Figure 1-1 shows the Westover Surplus Pumphouse site and Figures 1-2 through 1-5 show the individual locations for Pumphouses Nos. 1, 3, and 6, and Defueling Area No. 2, respectively. The boundary for each individual disposal site shown on Figures 1-2 through 1-5 was determined based on the horizontal extent of groundwater and soil contamination as defined in previous investigations (see GZA, 1994; ABB-ES, 1995b).

2.0 RISK CHARACTERIZATION

This risk characterization uses the information compiled during previous site investigation activities to assess the risk of harm to health, safety, public welfare, and the environment posed by OHM detected in soil and groundwater at the Westover Surplus Pumphouse site (the Site) at the former Westover AFB. The Site is composed of four areas to be evaluated: Pumphouse No. 1, Pumphouse No. 3, Pumphouse No. 6, and Defueling Area No. 2 (the Site also includes Pumphouse No. 2 which is undergoing further investigation as detailed in Section 1.0). The risk characterization is used to identify and evaluate site conditions which may pose an imminent hazard and to establish whether a level of no significant risk exists or has been achieved at the Site.

As required by the Massachusetts Contingency Plan 310 CMR 40.0000 (MCP, 1996), the compilation of site-specific information is necessary to adequately characterize the risk of harm to health, safety, public welfare, and the environment posed by contaminants present at the Site. Compiled information includes physical characteristics of the Site, the extent of release of OHM, and a characterization of contamination. Site-specific data sets were not developed for background concentrations in soil and groundwater. However, background soil and groundwater data is available from the literature and is considered in the risk characterization. Site-specific information is used to identify potential current and future human receptors, site activities and uses, exposure points, exposure pathways, and exposure point concentrations (EPCs) of site-related OHM. The selection of these parameters is conducted to provide a conservative estimate of the representative concentrations of OHM which a receptor may contact within the contaminated area over a period of time.

The accumulated information is used to identify site-specific groundwater and soil categories, and to identify the appropriate risk characterization method to be selected for the risk characterization. The results of the appropriate risk characterization method will be used to determine the need for remedial action or to demonstrate that a level of no significant risk of harm exists or has been achieved at the Site. The first seven subsections of the risk characterization which follows describe the methods used and information common to all of the four areas at the Site. The methods used are consistent with the MCP, Subpart I (310 CMR 40.0900 through 40.0999) (MCP, 1996). The results of the risk characterization are then discussed for each area at the Site individually in subsection 2.8.

2.1 SITE-SPECIFIC INFORMATION

As specified in 310 CMR 40.0904, adequate characterization of the Site is necessary prior to the characterization of risk of harm to health, safety, public welfare, and the environment. The purpose of this section is to describe unique physical characteristics of the Site which are critical to the risk characterization. See Subsection 1.1 for additional site information.

Pumphouse Nos. 1 and 3 each formerly contained a configuration of five 50,000 gallon underground storage tanks for JP-4, one 2,000 gallon underground water collection tank, a 25,000 gallon defueling tank, a pumphouse, dry well, and associated underground transmission pipelines. Defueling Area No. 2 consisted of one 25,000 gallon underground storage tank and associated pump and transmission lines. Pumphouse Nos. 1 and 3 and Defueling Area No. 2 were constructed between 1955 and 1958, and were not used from mid-1972 until deactivation in 1975. The facilities were excavated and are currently covered by grass and pavement. Pumphouse No. 6 contained two 50,000 gallon underground storage tanks for JP-4, a pumphouse, dry well, and underground transmission pipelines. Pumphouse No. 6 was constructed in 1953, deactivated in or about 1968, and demolished during 1977 and 1978.

Soil and groundwater contamination was identified during the three phases of the Comprehensive Site Assessment (GZA, 1994). OHM detected include volatile and semivolatile aromatic and aliphatic hydrocarbons consistent with the presence of jet fuel. Appendix A contains the data tables detailing contaminants detected at each area of the Site. Locations for samples listed in Appendix A are shown on Figures 1-2 through 1-5.

Groundwater at Westover AFB, at an average depth of 16 to 25 feet below ground surface, is not currently used onsite for potable or nonpotable purposes. No public water supply wells are located at the former Westover AFB. The groundwater at the three Pumphouse Areas are located in an area not mapped as potentially productive. The upgradient end of the Defueling Area No. 2 plume is located within a mapped medium, potentially productive aquifer, but the flow of that portion is away from the mapped drainage divide and the potentially productive aquifer. Groundwater likely discharges to surface water in Cooley Brook, approximately 3,000 feet downgradient from the Site. The GZA report (1994) concluded, however, that the plume has reached a steady-state condition and has not migrated off-site.

2.2 NATURE AND EXTENT OF CONTAMINATION

The extent of contamination at the Site is limited to OHM detected in groundwater and soil. The characterization is based on groundwater data collected during the three phases of the GZA field program, conducted in 1988-90, 1991-92, and 1993-94 as well as the ABB-ES groundwater monitoring program (ABB-ES, 1995b). Subsurface soil data were collected only during the 1988-89 field program, with the exception of three locations at Defueling Area No. 2 which were sampled in 1994. Sample results from all of these investigations have been combined to conduct a groundwater and soil risk characterization for the Site.

Soil data were available from the borings summarized in Appendix A. Samples analyzed for volatile organics were taken at 10 ft below ground surface (bgs) and 20 ft bgs in the majority of borings. The only exceptions are at Defueling Area No. 2 where only a 20 ft bgs sample was taken at WSB-511, a 1.5 ft bgs and a 20 ft bgs sample were taken at WSB-512 and 1.5 ft bgs, 15 ft bgs, and 20 ft bgs samples were taken at WSB-510. One sample at each area, taken in 1988-89, was analyzed for inorganics and semivolatile organics. Several unknown and tentatively identified compounds (TICs) were reported in a number of the samples. The concentration of all TICs in each sample are totalled and will be displayed on summary tables.

No TPH analysis data were available for subsurface soil. MADEP, in a letter dated July 14, 1994, concurred with the NED's and GZA's conclusion that the investigatory field work sufficiently characterized the Site (MADEP, 1994). Lack of TPH data adds a level of uncertainty to the evaluation of soil.

Groundwater sampling occurred in 1989, 1992, 1993, and 1994. Samples were analyzed for volatile and semivolatile compounds. One sample from each area was collected in 1989 and analyzed for dissolved metals. Total petroleum hydrocarbons were analyzed for in 1992. Also in 1992, two samples from three of the areas (Pumphouse No. 3, Pumphouse No. 6, and Defueling Area No. 2) were collected and analyzed for water quality, including total metals. The results for dissolved metals are used in the characterization, in addition to total inorganic analysis results, because all four areas are represented and the results for each are comparable to total metals. Results for volatile analysis by Analytical Methods 8040 and 8240 are combined. TICs were detected in groundwater and will be displayed as total concentrations on summary tables.

Additional data for VOCs and TPH in soil and groundwater were collected in this area by O'Reilly, Talbot & Okun in 1996 for the sale of the property to U.S. Tsubaki (see Appendix B). Well SB-8 is in the area of Pumphouse No. 1 and data from this location were incorporated into the data set for Pumphouse No. 1.

In 1990-91, Tighe & Bond sampled and analyzed for TPH in soil at the Pumphouse No. 6 area along the course of the Westover sewer interceptor (see Appendix C). The study was conducted for the portion of the sewer line adjacent to Pendleton Avenue where it intersects the northern portion of the disposal area. Sample locations occur in a line from MW-401 to MW-402 and overlap the GZA soil boring locations WSB-401 and WSB-402 (see Figure 1-4 and Appendix C, Figures 1 & 2). These data were incorporated into the Pumphouse No. 6 data set. Samples taken from 0 to 15 feet bgs were evaluated separately from samples taken from 16 to 22 feet bgs.

Results for groundwater and soil are presented in separate summary tables for each area at the Site (see Tables 2-2 through 2-9). Each data summary table lists the OHM, the frequency of detection, the range of sample quantitation limits (SQLs), and the minimum and maximum detected concentrations. The soil summary tables also include the arithmetic mean concentration of each OHM. Groundwater tables show the arithmetic mean only in the case, noted on the relevant tables, where a maximum concentration exceeds an MCP standard.

Maximum detected concentrations were identified prior to averaging duplicate analyses so that if a maximum were to be detected in one of a duplicate sample pair, a measured concentration rather than an averaged value would be reported as the maximum concentration. In calculating arithmetic averages for soil and groundwater contaminants, non-detects were assigned a value equal to one-half of the SQL for that particular chemical. In some cases, average concentrations calculated may exceed maximum detected concentrations due to elevated SQLs. For these compounds, maximum detected concentrations rather than arithmetic means were used as representative exposure point concentrations.

The soil and groundwater summary tables also contain a comparison of the maximum medium-specific concentrations to representative background levels, where appropriate or available. For groundwater, one onsite well (WMW-601) was placed upgradient of all four plumes but it was not determined if it was representative of basewide background conditions. Therefore, background levels of inorganic analytes in Massachusetts' groundwater, cited in the MADEP Risk Assessment Shortform (MADEP, 1992), were

used as screening concentrations. No basewide background data were available for soil. Therefore, MADEP background soil concentrations presented in Guidance for Disposal Site Risk Characterization (MADEP, 1995) were used as screening concentrations.

2.3 SELECTION OF OHM OF CONCERN

Those chemicals selected for evaluation in the risk characterization include all detected OHM with the following exceptions:

- Those OHM detected with a low frequency and at a low concentration. Contaminants present in environmental media at concentrations close to the SQL and at a low frequency of detection were excluded from further evaluation (MADEP, 1994).

- Those OHM detected at concentrations consistent with background. Consistency with background was determined for inorganic analytes by comparison of medium-specific maximum analyte concentrations to the MADEP Background Level. If the maximum sample concentration was less than the comparable background statistic, an analyte was determined to be consistent with background levels.

- Aquatic species must tolerate a range of sodium and calcium concentrations to survive in their natural environment. In fact, both sodium and calcium are critical to the well-being of most biological life. Although sodium and calcium may act as direct toxicants at extremely high levels, adverse effects following exposures to elevated concentrations are primarily associated with physiological effects such as osmotic stress. For freshwater fish species, it has been recommended that osmotic pressure levels not exceed that caused by a 15,000 mg/l sodium concentration (USEPA, 1976). Calcium can indirectly influence aquatic toxicity by affecting water hardness. Elevated calcium concentration generally has a beneficial effect because elevated hardness levels decrease the toxicity of a number of other inorganic analytes. Based on the groundwater data evaluated in this report, sodium and calcium concentrations appear to be substantially lower than those which would be associated with any adverse effects to aquatic life.

The data summary tables for each area summarize OHM of concern in soil and in groundwater. Reasons are noted for OHM eliminated from further evaluation. All inorganics detected in soil were excluded as OHM of concern based on consistency with MADEP background levels. For inorganics in groundwater, background values were available only for mercury, which was eliminated in all instances.

2.4 RECEPTOR INFORMATION

The next step in the risk characterization process is to provide a description of the Site in terms of its potential for human exposure. This phase is conducted by characterization of the exposure setting, including identification of potentially exposed human receptors and site activities and uses.

Four human receptor groups identified who could potentially be exposed to contamination at or resulting from the Site:

- industrial park workers
- trespassing children
- construction workers
- residents

The Site is currently part of an industrial park and will be for the foreseeable future. Workers in the industrial park near each former pumphouse or defueling location would be a potentially exposed population. Because the closest residential area is approximately 1/3-mile northwest of the Site, trespassing children are another potential receptor. Areas adjacent to the Site are used for a mixture of residential, recreational, and commercial purposes. No construction or excavation activities are occurring or are scheduled to occur in the foreseeable future. However, future construction and/or utility excavation cannot be excluded as a possibility, so construction workers are a potential receptor. Although the Site is likely to remain an industrial park and not become a residential area in the future, a future resident will be evaluated as a receptor for soil exposure to demonstrate that Activity and Use Limitations (AULs) are not required for the site. Groundwater beneath the Site is currently not believed to be contributing to a potentially productive aquifer and therefore has no receptors. However, groundwater from the Site could potentially discharge to nearby Cooley Brook. Potential receptors at Cooley Brook will be discussed in subsection 2.7.

2.5 IDENTIFICATION OF EXPOSURE POINTS, EXPOSURE ROUTES, AND EXPOSURE POINT CONCENTRATIONS

An exposure point is any point of potential contact with a contaminated medium. Exposure routes are the way in which a population may come in contact with a contaminated medium. The EPC is the concentration of the OHM which a receptor might contact at the exposure point. Potential exposure points and exposure routes were identified for soil and groundwater and are summarized in Table 2-1. EPCs are listed on the data summary tables for each area (see Tables 2-2 through 2-9).

There are no current exposures to groundwater onsite. Groundwater may discharge to Cooley Brook. Appendix D presents the results of fate and transport modeling to estimate the contribution of groundwater from each area on potential concentrations of OHM in surface water and sediment at Cooley Brook. In order to determine whether the potential extent of contamination in surface water and sediment represents a threat to human health, Appendix E presents risk calculations for a potential childhood recreational exposure to contaminants in Cooley Brook through incidental ingestion and dermal contact with surface water and sediment.

There is currently no potential exposure of Site trespassers and Site workers to soil contaminants because no contamination was identified in surface soil. Potential future exposures to construction workers could occur to subsurface soil if excavation/construction activities were to occur. Future site workers, trespassers, or residents could also be exposed to subsurface soil if excavation activities resulted in the relocation of subsurface soil to surficial locations. Routes of exposure would be incidental ingestion of, dermal contact with, and inhalation of particulates from soil.

EPCs for soil are the arithmetic mean of each OHM of concern. In cases where the mean concentration exceeded the maximum detected concentration for an OHM of concern, the maximum detected concentration was selected as the EPC.

For groundwater, each well located within each area of the Site is considered either a current or future exposure point. For a conservative assessment, the maximum concentration of each OHM of concern is used as an EPC. In the case where a maximum concentration exceeds an MCP standard, a temporal mean for the particular OHM is calculated for each well where the maximum concentration in that well exceeded the standard. The temporal mean in each affected well then becomes the more realistic EPC.

2.6 IDENTIFICATION OF SITE GROUNDWATER AND SOIL CATEGORIES

Categories of groundwater and soil have been established in the MCP (MCP, 1996) for use in risk characterization. Groundwater and soil categories are selected so that comparisons to the appropriate Method 1 groundwater and soil standards which are listed in 310 CMR 40.0974(2), 310 CMR 40.0975(6)(a), (b) and (c), and 310 CMR 40.0985(6) can be performed. Groundwater categories are also used to identify applicable or suitably analogous standards when Method 3 is used to characterize risk. Additionally, the groundwater and soil categories selected for a site are considered in determining the need for an AUL as part of a Response Action Outcome in accordance with 310 CMR 40.1012 and 310 CMR 40.1070 through 40.1089.

Three groundwater categories are described in 310 CMR 40.0932. Under the MCP, groundwater at all disposal sites is considered a potential source of discharge to surface water and, at a minimum, is classified as category GW-3. GW-3 standards are protective of aquatic life which may be present in surface water bodies. Groundwater category GW-1 applies to groundwater which is or may reasonably be expected to be used as a source of potable water or is in close proximity to a public or private water supply. Groundwater which is not in category GW-1, but is within 30 feet of an occupied structure and has an average annual depth to the water table of less than or equal to fifteen feet, is in category GW-2. Groundwater in category GW-2 is considered a potential source of vapors to indoor air. More than one groundwater category may be determined to be applicable. In such cases, all applicable categories should be identified.

Based on review of GIS maps, groundwater at the Site does not meet the criteria for classification as category GW-1. Site groundwater is not within a Zone II, Interim Wellhead Protection Area, or the Zone A of a Class A Surface Water Body, nor is it located 500 feet or more of a public water supply distribution pipeline or within 500 feet of a private water supply well. All of the plumes, except the upgradient (northern) portion of the Defueling Area No. 2 plume, are located in areas not mapped as potentially productive. The upgradient end of the Defueling Area No. 2 plume is located within a mapped medium, potentially productive aquifer. The boundary of the medium yield aquifer is a mapped drainage divide. Groundwater flow direction, documented in the GZA Phase II Report (GZA, 1994), shows the groundwater flow directions of all four site plumes away from this divide and the potentially productive aquifer. Historical data indicate that the direction of groundwater plume movement is also away from the potentially productive aquifer. The groundwater at the Site also does

not meet the criteria for classification as Category GW-2 because the average annual depth to groundwater at each of the areas is greater than 15 feet. Based on the criteria listed above, groundwater beneath each of the Site areas has been classified as category GW-3 for the purposes of this risk characterization.

Three soil categories have been identified in 310 CMR 40.0933. Soil is classified into either Category S-1, S-2, or S-3 based on site, receptor, and exposure information. While one and only one category is applicable to a specified volume of soil, soils in different areas of a disposal site may be classified in different categories, depending on their exposure potential. Category S-1 soils are associated with the highest potential for exposure while category S-3 soils have the lowest potential for exposure. The potential for exposure to soil is described by a qualitative analysis of the accessibility of the soil in combination with information concerning frequency and intensity of exposure for site activities and uses.

Accessibility. Under the MCP, the accessibility of soil to potential receptors may be characterized as accessible, potentially accessible, or isolated. The former Air Force Base is occupied by an industrial park which contains several buildings used for storage and commercial purposes and is surrounded by a mixture of paved and grassy areas. Therefore, soil surrounding buildings or in unpaved and grassy areas is considered to be potentially accessible, while soil beneath buildings and pavement or greater than 15 feet in depth, is considered to be isolated.

In general, most of the soil contamination identified at each of the Site areas is located proximate to the groundwater table (i.e., 16 to 25 feet bgs). The single exception is limited to small areas adjacent to boring WSB-510 in Defueling Area No. 2. Sample WSB-510 was collected from 1.5 feet to 3.5 bgs under a concrete, former airplane taxi-way.

Frequency and Intensity of Use. Frequency of use describes how often a receptor makes use of, or has access to, the site and surrounding environment. Frequency of use is described as either high or low. Since adults work at each of the Site areas, the frequency of use for adults may be characterized as high. Because the closest residential area is approximately 1/3 mile northwest of the Site, the frequency of use for children is considered to be low.

Intensity of use describes the nature of site activities and uses which could potentially result in exposure to the receptor, and is characterized as either high or low. Site

activities and uses which have the potential to disturb soil and result in either direct contact with soil or inhalation of soil-derived dust are characterized as high intensity use. Passive activities which do not disturb soil are described as low intensity use. Because accessibility of OHM in soil is generally low and activities and uses of the site as an industrial park do not disturb soil, intensity of site use is considered to be low. Adults who work at the facility perform the vast majority of their occupational activities inside of buildings. Additionally, children who trespass onto the site are not likely to engage in intrusive activities.

Based on the characterization of soil in terms of its accessibility and the frequency and intensity of site use by potential receptors, the Soil Category Selection Matrix presented in Table 40.933(9) of the MCP was used to identify soil categories applicable to the four areas under consideration. The qualitative evaluation indicated that adults are present at the areas and the frequency of use by these potential receptors is high while the intensity is low. For children, both the frequency and intensity of use is low. Therefore, both potentially accessible soils beneath paved areas or less than 15 feet deep as well as isolated soil more than 15 feet deep were classified as Category S-3.

Although soil has been classified as Category S-3, to achieve a condition of no significant risk without implementation of AULs (except in the case of soils greater than 15 feet deep), the level of contaminants in soil must be below Method 1 Category S-1 Soil Standards. Therefore, so that no AUL which restricts excavation or disturbance of site soils need be implemented, site concentrations will be compared to both S-1 and S-3 Soil Standards.

2.7 SELECTION OF A METHOD FOR RISK CHARACTERIZATION

The MCP (1996) describes risk characterization methods (310 CMR 40.0941(3)) available for the determination of the need for remedial action or to demonstrate that a level of no significant risk of harm to health, public welfare, and the environment exists or has been achieved. The methods have been developed to provide a range of approaches which vary in detail and circumstances of use, each of which provides equivalent levels of protection to health, public welfare, and the environment. The following sections detail the process involved for the selection of the appropriate risk characterization method and the implementation of the methodology.

There are currently three possible methods for characterizing risk to health, public welfare, and the environment per 310 CMR 40.0940 through 40.0996. These methods

characterize risk through the use of promulgated standards (Method 1), promulgated standards supplemented by site-specific information (Method 2), or the application of site-specific risk assessment methodologies (Method 3).

For this Site, the use of Method 1 appears to be appropriate since the extent of contamination is assumed to involve predominantly groundwater and soil. To support this assumption it is necessary to show that any potential impact of contaminants from the Site on surface water and sediment at Cooley Brook is small. Appendix D presents the results of the fate and transport modelling which estimated potential Cooley Brook contaminant discharge concentrations. Results from the models in Appendix D are used in Appendix E to calculate human health risk from contact with surface water and sediment under a childhood recreational exposure through incidental ingestion and dermal contact. For this evaluation, the maximum modelled concentration of each contaminant in sediment was used as the EPC for the most conservative approach. To provide the most conservative EPC for surface water, the sum of each plume's contribution to Cooley Brook was used. The results of the quantitative evaluation, summarized on Table C-1-3 in Appendix E, are a total carcinogenic risk of $1x10^{-9}$ and a noncarcinogenic risk of 0.001 for combined exposure to surface water and sediment. The carcinogenic risk is more than one order of magnitude below the MADEP MCP target risk of $1x10^{-5}$. The Hazard Index is also more than an order of magnitude below the MADEP target HI of 1. The evaluation indicates that the exposures for surface water and sediment are relatively minor and there is not a need to evaluate human health risks using Method 3. The Guidance for Disposal Site Risk Characterization (MADEP, 1995) indicates that if risks for media other than soil and groundwater are at least an order of magnitude below the MCP cumulative risk limits, it is not necessary to evaluate the whole site using Method 3.

The appropriate groundwater and soil promulgated Method 1 standards may be selected as a basis for comparison to Site EPCs, based on the selection of Site groundwater (GW-3) and soil (S-1, S-3) categories described in Subsection 2.6. However, since promulgated Method 1 standards are not available for a limited number of OHM of concern, a Method 2 Risk Characterization has been selected to allow for the development of groundwater standards for those OHM of concern lacking promulgated or proposed Method 1 Standards.

Method 1 standards are available for all OHM detected in soil. Method 2 GW-3 Standards are proposed for all analytes detected which lack Method 1 GW-3 Standards. These contaminants include iron, manganese, benzyl alcohol, 2-methylphenol, 4-

methylphenol, and dibenzofuran in groundwater. The MCP directs that GW-3 standards be developed based on ecologically-based Water Quality Criteria and may be modified to consider potential migration to surface water based on site-specific conditions Site specific conditions were used to develop the GW-3 Method 2 Standard for iron only. Method 2 Standards for the other analytes listed above were developed by a conservative, inexpensive process using default values. Everything but iron meets the default standard, so a site-specific standard was developed only for iron. Appendix F presents the development of GW-3 standards needed for this evaluation.

MCP standards are not available for TICs detected in soil and groundwater and cannot be developed since the identity of the OHM is unknown. TIC concentrations will be shown on summary tables although they cannot be evaluated.

To characterize the risk of harm to health, public welfare, and the environment, a combined Method 1/Method 2 Risk Characterization requires comparison of contaminant concentrations at the site to the promulgated MCP Method 1 and developed Method 2 soil and groundwater standards. For groundwater, existing water supply wells and monitoring wells will be considered current or potential exposure points for a combined Method 1/Method 2 Risk Characterization. For soil, exposure points will be based on the soil categories assigned to the volume of contaminated soil. EPCs at each exposure point will be estimated and compared to the applicable MCP Method 1 standard.

2.8 RISK CHARACTERIZATION RESULTS

The results of the Method 1/2 Risk Characterization for soil and groundwater at each of the four areas included in the Site are discussed below.

2.8.1 Pumphouse No. 1

Soil. The results of the soil risk characterization for Pumphouse No. 1 are shown on Table 2-2. All organic compounds detected in soil were selected as OHM of concern. All inorganics detected in soil were less than MADEP background soil concentrations and were eliminated as OHM of concern. The EPCs of the organic OHM are all less than both MCP S-1/GW-3 and S-3/GW-3 standards.

Groundwater. The results of the groundwater risk characterization for Pumphouse No. 1 are shown on Table 2-3. All organic compounds detected in groundwater were selected

as OHM of concern. Of the dissolved inorganics detected in groundwater, mercury was less than MADEP background groundwater concentration and was eliminated as an OHM of concern. Sodium was eliminated because it is not toxic to aquatic organisms at detected concentrations. The data from the O'Reilly, Talbot & Okun investigation were presumed to be for total inorganics. Lead was detected and selected as an OHM of concern. The maximum concentrations of the OHM of concern are all less than the MCP GW-3 standards.

2.8.2 Pumphouse No. 3

Soil. The results of the soil risk characterization for Pumphouse No. 3 are shown on Table 2-4. All organic compounds detected in soil were selected as OHM of concern. All inorganics detected in soil were less than MADEP background soil concentrations and were eliminated as OHM of concern. The EPCs of the organic OHM of concern are all less than both MCP S-1/GW-3 and S-3/GW-3 standards.

Groundwater. The results of the groundwater risk characterization for Pumphouse No. 3 are shown on Table 2-5. All organic compounds detected in groundwater were selected as OHM of concern except carbon disulfide which is eliminated based on its low frequency of detection. Of the dissolved inorganics detected in groundwater, mercury was less than MADEP background groundwater concentration and was eliminated as an OHM of concern. Sodium was eliminated from dissolved and total groundwater because it is not toxic to aquatic life at detected concentrations. Calcium was eliminated from total groundwater for the same reason. The maximum concentrations of the OHM of concern in groundwater are all less than the MCP GW-3 standards. The maximum concentrations of TPH are less than the GW-3 standard.

2.8.3 Pumphouse No. 6

Soil. The results of the soil risk characterization for Pumphouse No. 6 are shown on Table 2-6. All organic compounds detected in soil were selected as OHM of concern. All inorganics detected in soil were less than MADEP background soil concentrations and were eliminated as OHM of concern. The EPCs of the organic OHM of concern are all less than both MCP S-1/GW-3 and S-3/GW-3 standards. The EPC for TPH detected in soil from 0 to 15 feet bgs is less than the S-1/GW-3 and S-3/GW-3 standards. The EPC for TPH detected in soils greater than 15 feet bgs is not compared to the S-1/GW-3 standard because soils at that depth have such a low potential for exposure; they are classified as S-3 and would remain so classified without an AUL per

310 CMR 40.1012 (3)(b). The EPC is less that the S-3/GW-3 standard. Based on TPH results, Tighe & Bond performed a remediation which removed soil from 16 to 22 feet bgs (see Appendix C, Figure 2).

Groundwater. The results of the groundwater risk characterization for Pumphouse No. 6 are shown on Table 2-7. All organic compounds detected in groundwater were selected as OHM of concern. Of the dissolved inorganics detected in groundwater, mercury was less than MADEP background groundwater concentration and was eliminated as an OHM of concern. Sodium was eliminated from dissolved and total groundwater because it is not toxic to aquatic life at detected concentrations. Calcium was eliminated from total groundwater for the same reason. The maximum concentrations of the organic and inorganic OHM of concern are all less than the MCP GW-3 standards, with the exception of bis(2-ethylhexyl)phthalate (BEHP). The temporal mean, i.e., an arithmetic mean of BEHP results for all rounds of sampling in the well in which the exceedance occurred (WMW-406I), was then calculated. The temporal mean for BEHP does not exceed the standard. The maximum concentration of TPH is less than the GW-3 standard for TPH.

2.8.4 Defueling Area No. 2

Soil. The results of the soil risk characterization for Defueling Area No. 2 are shown on Table 2-8. All organic compounds detected in soil were selected as OHM of concern. All inorganics detected in soil were less than MADEP background soil concentrations and were eliminated as OHM of concern. The EPCs of the organic OHM of concern are all less than both MCP S-1/GW-3 and S-3/GW-3 standards.

Groundwater. The results of the groundwater risk characterization for Defueling Area No. 2 are shown on Table 2-9. All organic compounds detected in groundwater were selected as OHM of concern. Of the inorganics detected in groundwater, dissolved mercury was less than MADEP background groundwater concentration and was eliminated as an OHM of concern. Sodium and calcium were eliminated from total inorganics because they are not toxic to aquatic life at concentrations detected. The maximum concentrations of the OHM of concern are all less than the MCP GW-3 standards. The maximum concentrations of TPH are less than the GW-3 standard for TPH.

ABB Environmental Services, Inc., 1995a. *Phase I Site Investigation Report, Lonczak Drive Area, Former Westover Air Force Base, Chicopee, Massachusetts;* Prepared for U.S. Army Corps of Engineers, New England Division; Contract No. DACA33-91-D-0006; January 1995.

ABB Environmental Services, Inc., 1995b. *1994 Yearly Groundwater Monitoring Report, Groundwater Monitoring Program, Former Westover Air Force Base, Chicopee, Massachusetts;* Prepared for U.S. Army Corps of Engineers, New England Division; Contract No. DACA33-91-D-0006; January 1995.

Department of the Army, 1995. *Scope of Work for The Completion of Response Action Outcome (RAO) Statements and Release Abatement Measure (RAM) Plans at Former Westover AFB, Chicopee, Massachusetts*; U.S. Army Corps of Engineers, Contract No. DACW33-94-D-0007; October 3, 1995. Revised January 10, 1996.

GZA GeoEnvironmental, Inc. (GZA), 1994. *Phase II Investigation Report, Former Westover Air Force Base, Chicopee, Massachusetts, Site No. 1-0299, Volumes I, II, and III;* prepared for U.S. Army Corps of Engineers, New England Division; August 1994.

Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, 1992. *Risk Assessment Shortform - Residential Exposure Scenario*. Office of Research and Standards and the Bureau of Waste Site Cleanup; September.

Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, 1995. *The Massachusetts Contingency Plan, 310 CMR 40.0000*; September 9, 1996.

Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, 1995. *Guidance for Disposal Site Risk Characterization.* In Support of the Massachusetts Contingency Plan; July.

Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, 1996. *Implementation of the MCP Requirement for Evaluating the Feasibility of Approaching or Achieving Background; Issues Paper*; May 15.

O'Reilly, Talbot & Okun, 1996. Environmental Site Assessment, 106 Lonczak Drive, Chicopee, MA; June 3, 1996.

3.0 RAO CONCLUSIONS

3.1 CONCLUSIONS

A risk characterization was performed for four areas at the Site to identify and evaluate site conditions which may pose an imminent hazard and to establish whether a level of no significant risk exists or has been achieved at the Site. The methods used are consistent with the MCP, Subpart I (310 CMR 40.0900 through 40.0999) (MCP, 1996).

It was determined that a Method 1/Method 2 risk characterization was suitable for the Site. Based on factors of accessibility of soil in combination with information about frequency and intensity of exposure as described in 310 CMR 40.0933, soils are classified as Category S-3. However, so that no AUL which restricts excavation or disturbance of site soils need be implemented, soil concentrations in the top 15 feet were compared to both S-1 and S-3 Soil Standards. For soils deeper than 15 feet, concentrations were compared to S-3/GW-3 standards. These soils will remain S-3/GW-3 soils even in the absence of an AUL. Based on the criteria set forth in 310 CMR 40.0932, groundwater beneath each of the Site areas has been classified as category GW-3 for the purposes of this risk characterization; that is, it is considered a potential source of discharge to surface water. GW-3 standards were developed for a limited number of OHM lacking Method 1 standards.

OHM of concern and EPCs were selected based on MCP criteria and compared to Method 1/Method 2 standards to characterize risk. Results of the risk characterization indicate that no OHM of concern in soil exceed Method 1 standards. In groundwater, no OHM of concern exceed Method 1/Method 2 standards.

Because there are no current exposures or hazardous conditions at the Site, a condition of no significant risk to safety has been achieved. No releases of OHM are likely to occur under present or foreseeable future conditions, so conditions at the Site do not pose a risk to safety or public health.

The requirements of a Class B-1 RAO consistent with the Revised MCP Subpart I (310 CMR 40.1046) have been met for Pumphouse No. 1, Pumphouse No. 3, and Defueling Area No. 2 of the Former Pumphouse Site because a level of No Significant Risk exists and no AUL is necessary to ensure the existence or maintenance of a level of No Significant Risk for these areas of the Site. Because remediation activity has occurred at Pumphouse No. 6 of the former pumphouse site, it was evaluated for a Class A-2 RAO.

The requirements of a Class A-2 RAO consistent with the MCP Subpart 1 (310 CMR 40.1036) have been met for Pumphouse No. 6 because a permanent solution has been achieved, the level of OHM has not been reduced to background, and activity and use limitations are not required to maintain a level of no significant risk.

3.2 Evaluation for Feasibility of Approaching Background

Under 310 CMR 40.0890, 40.1020, and 40.1056, the feasibility of approaching or achieving background must be evaluated at any site where a permanent solution is used to achieve a level of No Significant Risk. This evaluation is performed for Pumphouse No. 6 in the following paragraphs using guidance provided in the issues paper "Implementation of the MCP Requirement for Evaluating the Feasibility of Approaching or Achieving Background" (MADEP, 1996). In accordance with 310 CMR 40.1045 and the aforementioned issues paper (MADEP, 1996), a feasibility of background evaluation is not required for Class B RAOs.

Groundwater. Approaching or achieving background in groundwater is infeasible because:

Remediation of groundwater is not necessary to meet the condition of No Significant Risk.

- Average concentrations of all OHM in groundwater are less than GW-3 standards.
- The MADEP issues paper (MADEP, 1996) suggests that one possible definition of approaching background is when analytical results meet No Significant Risk levels without averaging. Maximum concentrations of OHM in groundwater are less than GW-3 standards with the exception of BEHP. The maximum concentration of BEHP barely exceeds the GW-3 standard.

Site-specific background values for groundwater have not been determined and developing them would be costly. Compared to MADEP groundwater background, mercury concentrations do not exceed background. Maximum concentrations of other inorganics in groundwater are at least an order of magnitude less than the respective GW-3 standard.

Costs associated with groundwater treatment to achieve background or non-detect levels are typically prohibitively high (MADEP, 1996; USEPA, 1993).

Soil. Approaching or achieving background in soil is infeasible because:

- The permanent solution at Pumphouse No. 6 was achieved during a sewer expansion in 1991 when soil was excavated to a depth of 22 feet bgs along the sewer line and replaced with clean fill, thereby removing the highest concentrations of organic OHM. Because this remediation has already occurred, any attempt to achieve or approach background at this time would mean the cost of an entirely new remediation effort at the site.

- Six samples were taken at depths below the excavated soil in the sewer line and show TPH concentrations ranging from 6 mg/kg to 1600 mg/kg. These concentrations do not exceed the S-3 standard for TPH of 5000 mg/kg. Little additional benefit would be derived in comparison to cost if these inaccessible soils, where a condition of No Significant Risk has already been achieved, were remediated to background.

- No site-specific background values are available for organic or inorganic chemicals in soil. Compared to MADEP background soil concentrations, which were used in the absence of site-specific background data, Pumphouse No. 6 has does not exceed background for inorganics in soil.

- The MADEP issues paper (MADEP, 1996) suggests that one possible definition of approaching background is when analytical results meet No Significant Risk levels without averaging. Maximum concentrations of organic OHM which remain after excavation are all less than S-1/GW-3 standards, except for some detections of TPH in the sewer trench at depths greater than 22 feet bgs. Compared to S-3/GW-3 standards, which are more appropriate for soils at this depth, no detections exceed standards.

- Site-specific background values for soil have not been determined and developing them would be costly. If background for organics were assumed to be zero, achieving background in soil would involve excavation of areas with contaminant concentrations that are less than No Significant Risk levels and re-excavation of the sewer line to below 22 ft bgs, including removal of clean fill. However, MADEP (1996) comments that

background does not necessarily equal pristine conditions. Some level of organic background contamination is likely to exist in area soils because Pumphouse No. 6 is in a location where human activities over the years would have resulted in the presence of some organic compounds in the environment. If site-specific background levels were established, removal activities might still be necessary to achieve background.

3.3 Activity and Use Limitation Statement

Per 310 CMR 40.1012, an AUL is not necessary to meet either the RAO Class A-2 (Pumphouse No. 6) or Class B-1 (Pumphouse No. 1, Pumphouse No. 3, and Defueling Area No. 2) conditions because EPCs for all OHM in soils less than or equal to 15 feet bgs meet Method 1 S-1 soil standards.

3.4 LSP Opinion and Certification

The LSP Opinion and Certification by the person undertaking the response action are included in the RAO Statement transmittal form filed with this report.

ABB-ES	ABB Environmental Services, Inc.
AFB	Air Force Base
AUL	Activity and Use Limitation
BEHP	bis(2-ethylhexyl)phthalate
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CQRL	Contract Required Quantitation Limit
EPC	exposure point concentration
GZA	GZA GeoEnvironmental, Inc.
LDA	Lonczak Drive Area
LSP	Licensed Site Professional
MADEP	Massachusetts Department of Environmental Protection
MCP	Massachusetts Contingency Plan
mg/kg	milligrams per kilogram
NED	U.S. Army Corps of Engineers, New England Division
OHM	oil and/or hazardous material
ppm	parts per million
PQL	Practical Quantitation Limit
RAM	Release Abatement Measure
RAO	Response Action Outcome
RTN	Release Tracking Number
SI	Site Investigation
SQL	Sample Quantitation Limit
SVOC	Semivolatile Organic Compound
TCL	Target Compound List
TIC	tentatively identified compound

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

TPH	Total Petroleum Hydrocarbon
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound
WMDC	Westover Metropolitan Development Corporation

ABB Environmental Services, Inc., 1995a. *Phase I Site Investigation Report, Lonczak Drive Area, Former Westover Air Force Base, Chicopee, Massachusetts;* Prepared for U.S. Army Corps of Engineers, New England Division; Contract No. DACA33-91-D-0006; January 1995.

ABB Environmental Services, Inc., 1995b. *1994 Yearly Groundwater Monitoring Report, Groundwater Monitoring Program, Former Westover Air Force Base, Chicopee, Massachusetts;* Prepared for U.S. Army Corps of Engineers, New England Division; Contract No. DACA33-91-D-0006; January 1995.

Department of the Army, 1995. *Scope of Work for The Completion of Response Action Outcome (RAO) Statements and Release Abatement Measure (RAM) Plans at Former Westover AFB, Chicopee, Massachusetts*; U.S. Army Corps of Engineers, Contract No. DACW33-94-D-0007; October 3, 1995. Revised January 10, 1996.

GZA GeoEnvironmental, Inc. (GZA), 1994. *Phase II Investigation Report, Former Westover Air Force Base, Chicopee, Massachusetts, Site No. 1-0299, Volumes I, II, and III;* prepared for U.S. Army Corps of Engineers, New England Division; August 1994.

Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, 1992. *Risk Assessment Shortform - Residential Exposure Scenario*. Office of Research and Standards and the Bureau of Waste Site Cleanup; September.

Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, 1995. *The Massachusetts Contingency Plan, 310 CMR 40.0000*; September 9, 1996.

Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, 1995. *Guidance for Disposal Site Risk Characterization.* In Support of the Massachusetts Contingency Plan; July.

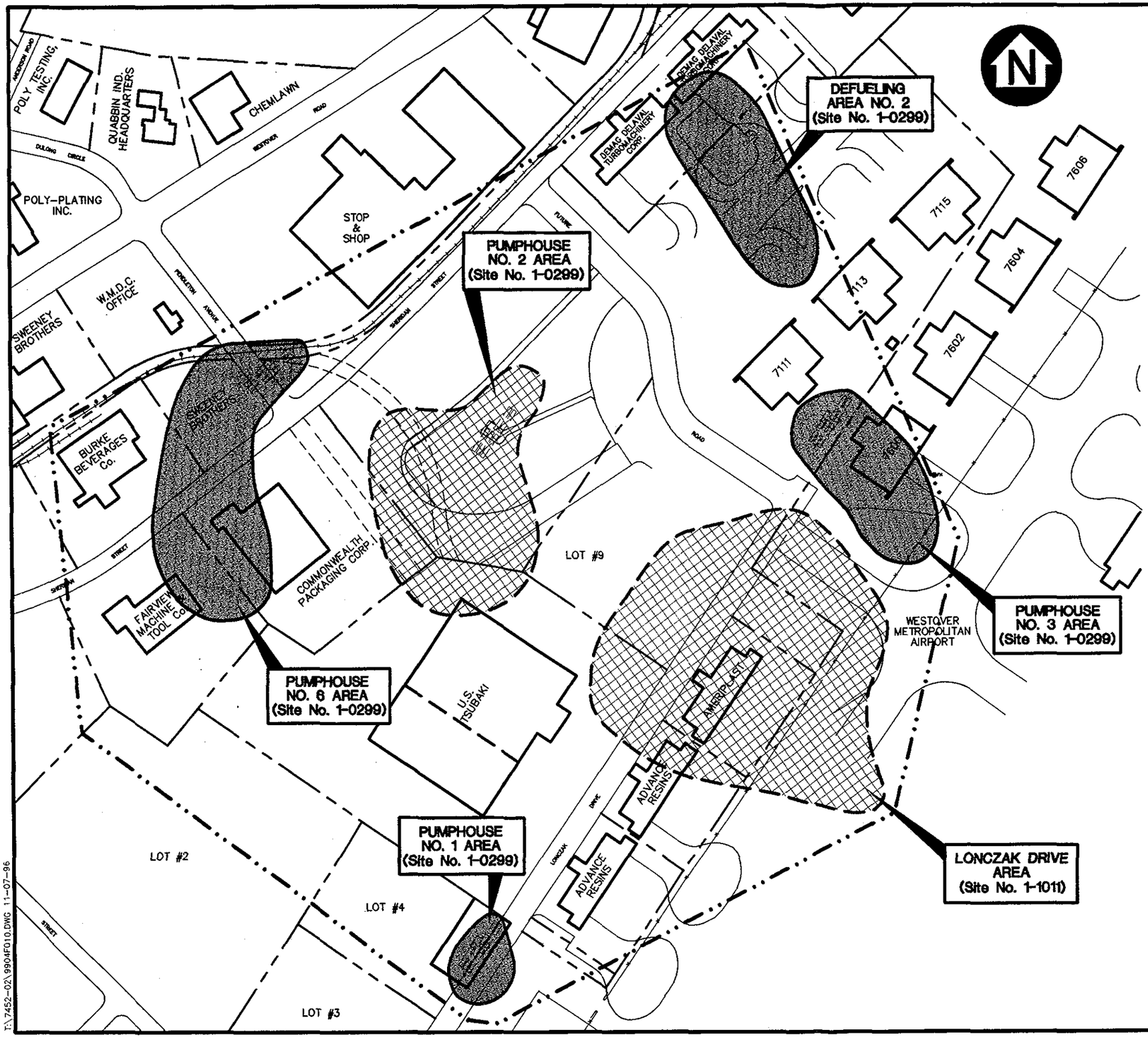
Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, 1996. *Implementation of the MCP Requirement for Evaluating the Feasibility of Approaching or Achieving Background; Issues Paper*; May 15.

O'Reilly, Talbot & Okun, 1996. Environmental Site Assessment, 106 Lonczak Drive, Chicopee, MA; June 3, 1996.

REFERENCES

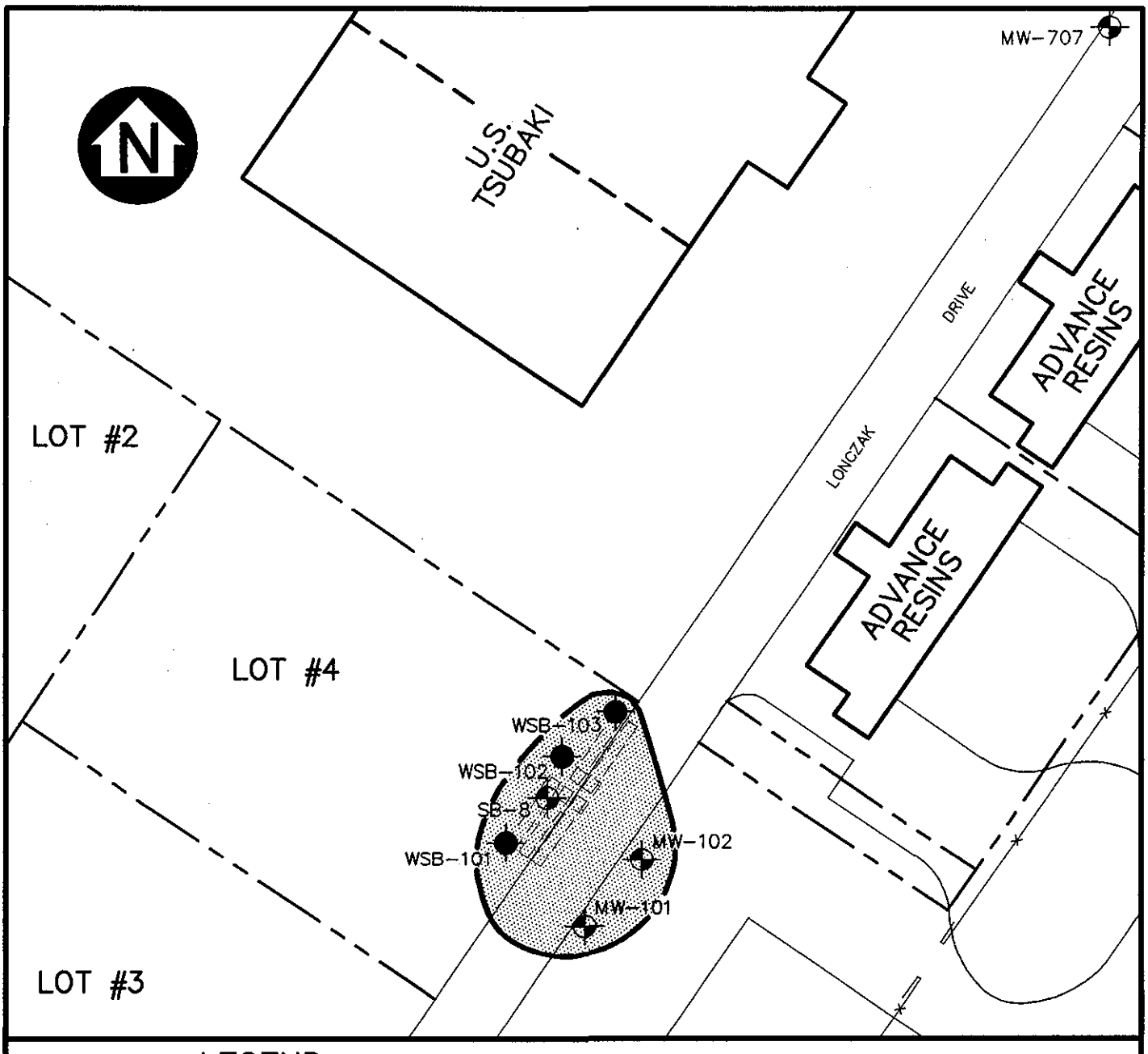
Tighe & Bond, 1991. Letter from Mr Evan T. Johnson, P.E., Tighe & Bond, Westfield, MA to Ms. Catherine Wanat, Massachusetts Dept. of Environmental Protection, Springfield, MA *Re: On-site TPH Analysis, Westover Interceptor Sewer*; April 4.

USEPA, 1976. *Quality Criteria for Water*; USEPA, Washington, D.C., July, 1976; 267 pp.



T:\7452-02\9904F010.DWG 11-07-96

FIGURE 1-1
WESTOVER SURPLUS PUMPHOUSE SITE NO. 1-0299
RESPONSE ACTION OUTCOME STATEMENT
WESTOVER SURPLUS PUMPHOUSE SITE
ABB Environmental Services, Inc.



LEGEND

- DISPOSAL SITE BOUNDARY
- PROPERTY LINE
- FENCE
- WSB-101 — SOIL BORING LOCATION
- MW-101 — MONITORING WELL LOCATION
- FORMER PUMPHOUSE FACILITIES

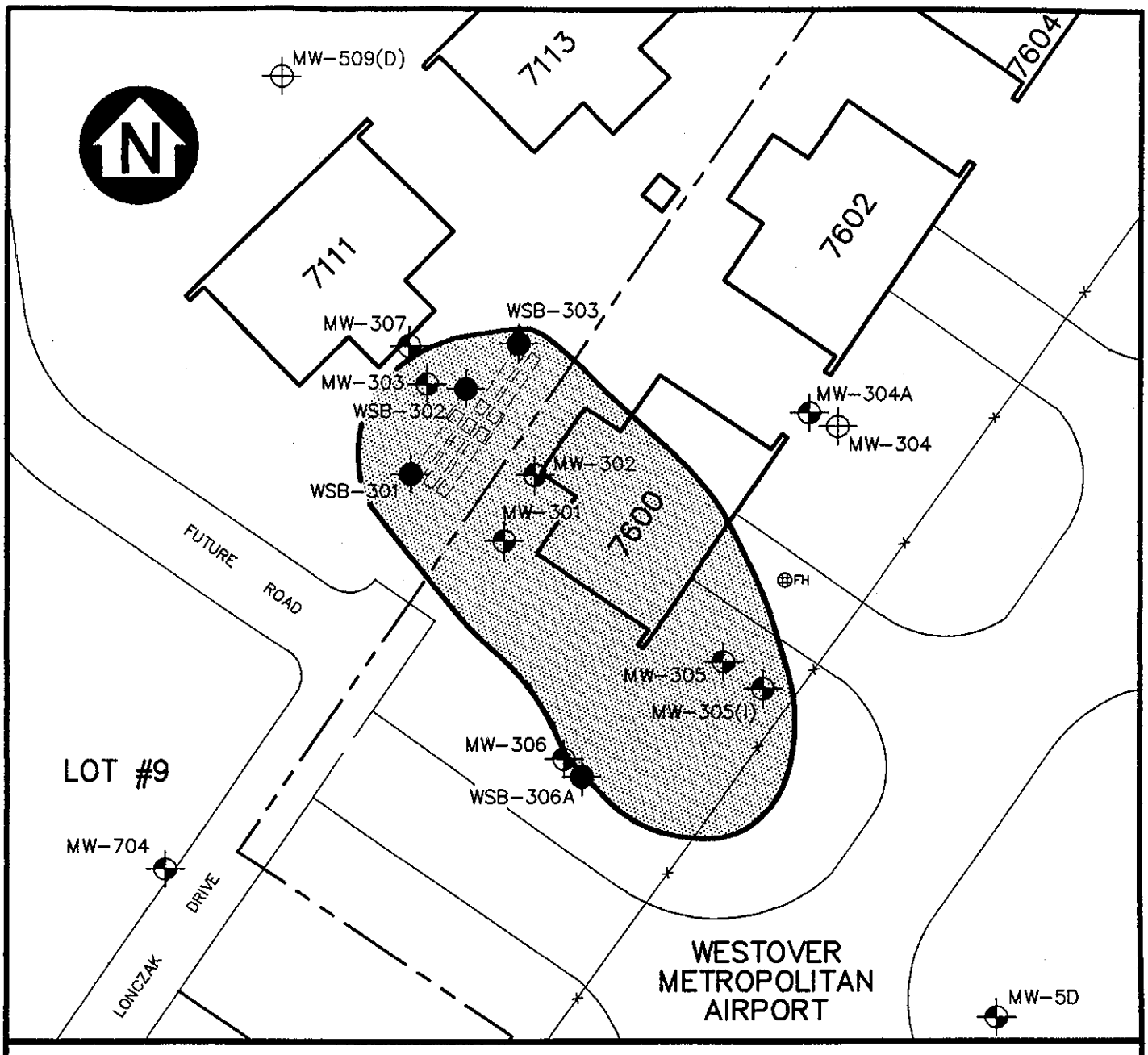
0 75 150 300 FEET

SCALE: 1" = 150'

NOTES:

1. DISPOSAL SITE BOUNDARY BASED ON HORIZONTAL EXTENT OF GROUNDWATER AND SOIL CONTAMINATION AS DEFINED IN PREVIOUS INVESTIGATIONS (SEE GZA, 1994; ABB-ES, 1995)
2. LOCATION OF SB-8 IS APPROXIMATE BASED ON FIGURE 2 FROM O'REILLY, TALBOT & OKUN, 1996.

FIGURE 1-2
PUMPHOUSE NO. 1 - DISPOSAL SITE BOUNDARY
RESPONSE ACTION OUTCOME STATEMENT
WESTOVER SURPLUS PUMPHOUSE SITE
ABB Environmental Services, Inc.



LEGEND

- DISPOSAL SITE BOUNDARY
- PROPERTY LINE
- FENCE
- MW-306 — MONITORING WELL LOCATION
- WSB-303 — SOIL BORING LOCATION
- MW-304 — LOCATION OF DESTROYED MONITORING WELL
- FORMER PUMPHOUSE FACILITIES

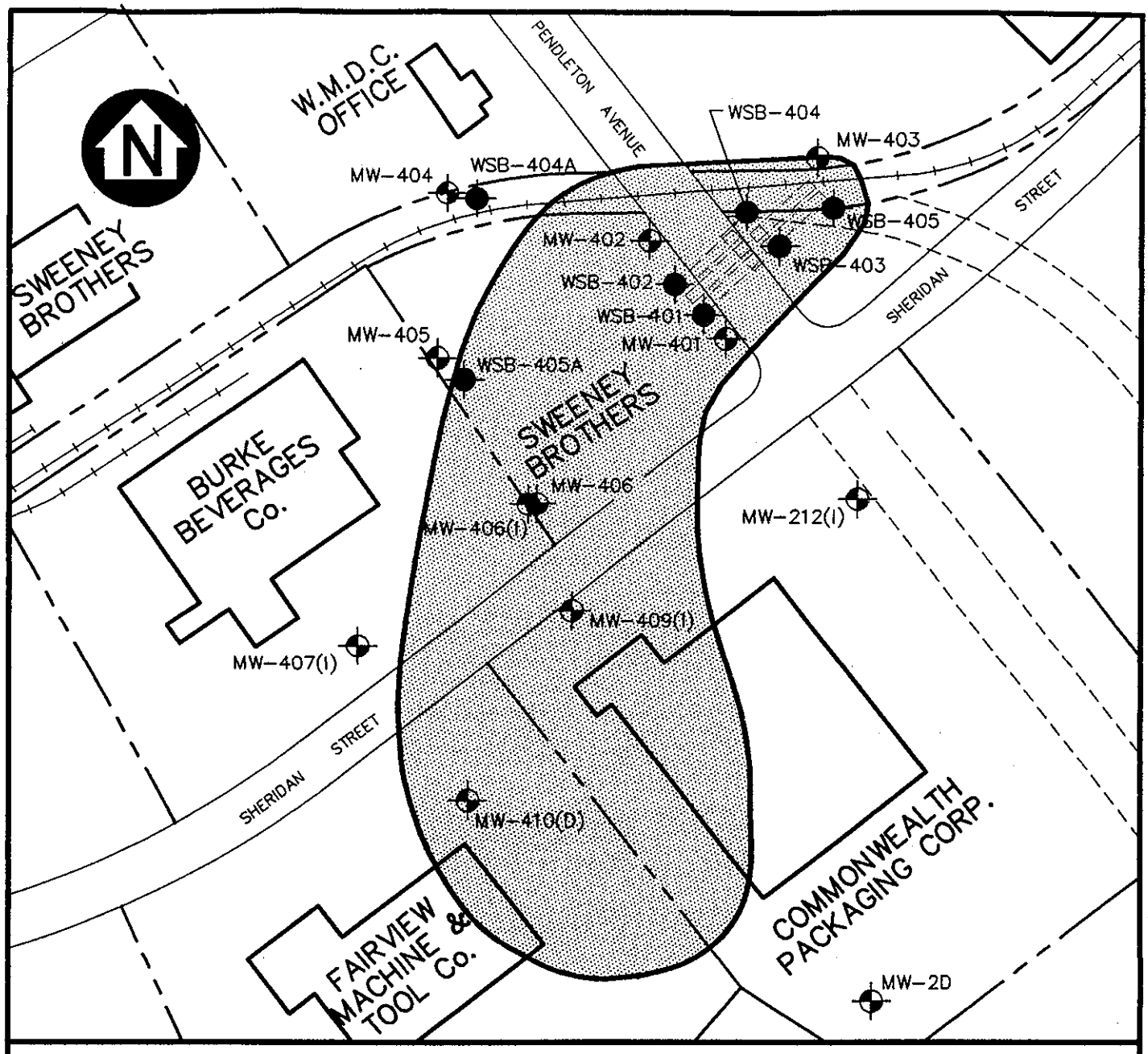
NOTE:
DISPOSAL SITE BOUNDARY BASED ON HORIZONTAL EXTENT OF GROUNDWATER AND SOIL CONTAMINATION AS DEFINED IN PREVIOUS INVESTIGATIONS (SEE GZA, 1994; ABB-ES, 1995)

0 75 150 300 FEET

SCALE: 1"=150'

FIGURE 1-3
PUMPHOUSE NO. 3 - DISPOSAL SITE BOUNDARY
RESPONSE ACTION OUTCOME STATEMENT
WESTOVER SURPLUS PUMPHOUSE SITE
ABB Environmental Services, Inc.

T:\7452-02\9904F006.DWG 5-8-96



LEGEND

- DISPOSAL SITE BOUNDARY
- PROPERTY LINE
- RAILROAD TRACKS
- WSB-405 — SOIL BORING LOCATION
- MW-405 — MONITORING WELL LOCATION
- FORMER PUMPHOUSE FACILITIES

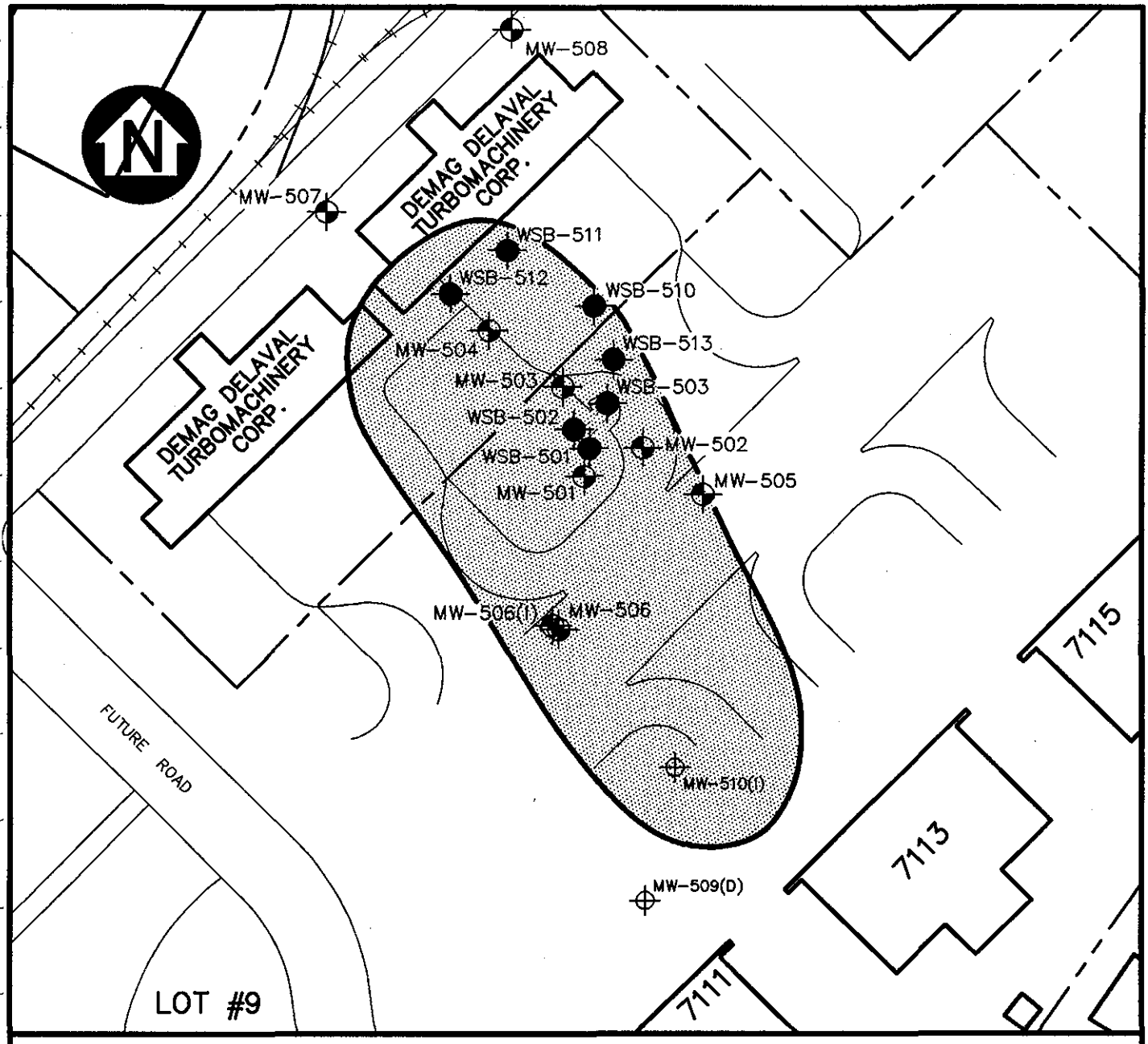
NOTE:
DISPOSAL SITE BOUNDARY BASED ON HORIZONTAL EXTENT OF GROUNDWATER AND SOIL CONTAMINATION AS DEFINED IN PREVIOUS INVESTIGATIONS (SEE GZA, 1994; ABB-ES, 1995)

0 75 150 300 FEET

SCALE: 1"=150'

FIGURE 1-4
PUMPHOUSE NO. 6 - DISPOSAL SITE BOUNDARY
RESPONSE ACTION OUTCOME STATEMENT
WESTOVER SURPLUS PUMPHOUSE SITE
ABB Environmental Services, Inc.

T:\7452-02\9904F009.DWG 5-7-96



LEGEND

- DISPOSAL SITE BOUNDARY
- PROPERTY LINE
- RAILROAD TRACKS
- WSB-501 — SOIL BORING LOCATION
- MW-501 — MONITORING WELL LOCATION
- MW-509(D) — LOCATION OF DESTROYED MONITORING WELL

NOTE:
DISPOSAL SITE BOUNDARY BASED ON HORIZONTAL EXTENT OF GROUNDWATER AND SOIL CONTAMINATION AS DEFINED IN PREVIOUS INVESTIGATIONS (SEE GZA, 1994; ABB-ES, 1995)

0 75 150 300 FEET

SCALE: 1"=150'

FIGURE 1-5
DEFUELING NO. 2 - DISPOSAL SITE BOUNDARY
RESPONSE ACTION OUTCOME STATEMENT
WESTOVER SURPLUS PUMPHOUSE SITE
ABB Environmental Services, Inc.

TABLE 2-1
POTENTIAL EXPOSURE PATHWAYS

WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

Potential Exposure Pathways	Potentially Exposed Population	Is Pathway Complete?	Comments
Groundwater			
Ingestion, dermal contact and inhalation of volatiles	Trespassers	No current or future exposures.	No known wells or seeps onsite.
	Industrial Park Workers	No current exposures.	Site groundwater is not a current source of potable or non-potable water.
		Potential future exposures unlikely.	Site groundwater in an area not mapped as potentially productive as a potable water source.
	Construction Workers	No current exposures.	No current excavation.
		Potential future exposures unlikely.	Excavation not likely to occur to water table.
Soil			
Incidental ingestion, dermal contact and inhalation of particulates	Trespassers	No current exposure.	Contaminated soil is located below the surface.
		Potential future exposure could occur.	Future excavation could bring subsurface soil to surface.
	Industrial Park Workers	No current exposure.	Contaminated soil is located below the surface.
		Potential future exposure could occur.	Future excavation could bring subsurface soil to surface.
	Construction Workers	No current exposures.	No current excavation.
		Potential future exposures could occur.	Construction workers could potentially be exposed in the future for a limited period if excavation occurs.

TABLE 2-2
METHOD 2 RISK CHARACTERIZATION FOR SOIL
PUMPHOUSE NO. 1

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	Arithmetic Mean of all Samples[1]	EPC[2]	MADEP Background Soil Conc[3]	OHM of Concern?	Notes	MCP S1/GW3 Standards[4] for CPCs	EPC Exceeds MCP Standard?	MCP S3/GW3 Standards[4] for CPCs	EPC Exceeds MCP Standard?
SOIL SAMPLES (mg/kg)													
VOLATILE ORGANIC COMPOUNDS[5]													
1,1,1-Trichloroethane	0.0052 : 0.0057	4 / 11	0.01	0.018	0.0062	0.0062	NBD	Yes		100	No	500	No
Acetone	0.01 : 0.01	8 / 11	0.008	0.056	0.0201	0.0201	NBD	Yes		60	No	60	No
Methylene Chloride		10 / 11	0.002	0.02	0.0075	0.0075	NBD	Yes		100	No	700	No
Tetrachloroethene	0.0052 : 0.0057	1 / 11	0.003	0.003	0.0027	0.0027	NBD	Yes		200	No	500	No
Toluene	0.0052 : 0.0053	5 / 11	0.001	0.002	0.002	0.002	NBD	Yes		500	No	2500	No
m,p-Xylenes	0.1 : 0.1	1 / 11	0.08	0.08	0.08[7]	0.08	NBD	Yes		500	No	5000	No
o-Xylenes	0.05 : 0.05	1 / 11	0.05	0.05	0.08[7]	0.08	NBD	Yes		500	No	5000	No
SEMIVOLATILE ORGANIC COMPOUNDS[6]													
bis(2-Ethylhexyl)phthalate		1 / 1	0.075	0.075	0.075	0.075	NBD	Yes		200	No	500	No
INORGANICS[6]													
Barium		1 / 1	21.9	21.9	21.9	21.9	45	No	Background[8]				
Chromium		1 / 1	5.97	5.97	5.97	5.97	29	No	Background[8]				
Mercury		1 / 1	0.12	0.12	0.12	0.12	0.3	No	Background[8]				
OTHER[5,6]													
Tentatively Identified Compounds		1 / 12	2.7	2.7	2.7[7]	2.7	NBD	Yes		NA	NE	NA	NE

Notes:

[1] Arithmetic mean of detected concentrations plus 1/2 of SQL for nondetects

[2] The lesser of the arithmetic mean and the maximum detected concentration

[3] From "Guidance for Disposal Site Risk Characterization" (MADEP, 1995)

[4] From 310 CMR 40.0975 (MCP, 1995)

[5] Based on analytical data from the following sample locations: WMW-101, WMW-102, WSB-101, WSB-102, WSB-103, all with one sample taken at 10 ft and one at 20 ft bgs and from SB-8/S-7 taken at 30 ft bgs.

[6] Based on analytical data from sample WMW-102, taken at 25 ft bgs.

[7] Mean of detects. Unable to calculate mean of all samples because no SQL data were available.

[8] All detected concentrations are less than background concentration

ACRONYMS:

SQL = Sample Quantitation Limit
EPC = Exposure Point Concentration
Conc. = Concentration
MADEP = Massachusetts Department of Environmental Protection
CPC = Compound of Potential Concern
MCP = Massachusetts Contingency Plan
NBD = No Background Determined
NA = None Available
ft bgs = feet below ground surface
mg/kg = milligram per kilogram
NE - Not evaluated because MCP standards not available
OHM - Oil or Hazardous Material

TABLE 2-3
METHOD 2 RISK CHARACTERIZATION FOR GROUNDWATER
PUMPHOUSE NO. 1

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	EPC[1]	MADEP Background Groundwater Conc[2]	OHM of Concern?	Notes	MCP GW3 Standards[3] for CPCs	EPC Exceeds MCP Standard?
GROUNDWATER SAMPLES (mg/L)										
VOLATILE ORGANIC COMPOUNDS [4]										
Acetone	0.01 : 0.075	2 / 8	0.007	0.016	0.016	NBD	Yes		50	No
Ethylbenzene	0.005 : 0.005	2 / 8	0.099	0.57	0.57	NBD	Yes		4	No
Methyl tert-butyl ether	0.01 : 0.01	1 / 8	0.14	0.14	0.14	NBD	Yes		50	No
Methylene chloride	0.005 : 0.005	1 / 8	0.002	0.002	0.002	NBD	Yes		50	No
Toluene	0.005 : 0.005	3 / 8	0.003	0.64	0.64	NBD	Yes		50	No
Total Xylenes	0.005 : 0.005	4 / 8	0.002	1.97	1.97	NBD	Yes		50	No
DISSOLVED INORGANICS[5]										
Iron		1 / 1	0.203	0.203	0.203	NBD	Yes		967 [8]	No
Manganese		1 / 1	0.406	0.406	0.406	NBD	Yes		2.8 [8]	No
Mercury		1 / 1	0.00075	0.00075	0.00075	0.0010	No	Background[6]		
Sodium		1 / 1	5.58	5.58	5.58	NBD	No	Nutrient[7]		
TOTAL INORGANICS [9]										
Lead	0.001 : 0.001	1 / 1	0.005	0.005	0.005	NBD	Yes		30	No
OTHER										
Total Petroleum Hydrocarbons [10]		1 / 2	0.022	0.022	0.022	NBD	Yes		50	No
Tentatively Identified Compounds [4]		1 / 8	0.039	0.039	0.039	NBD	Yes		NA	NE

Notes:

[1] The maximum detected concentration or, if the maximum exceeds the standard, the mean concentration of compound in well where exceedance was detected

[2] From "Guidance for Disposal Site Risk Characterization" (MADEP, 1995)

[3] From 310 CMR 40.0975 (MCP, 1995), unless otherwise noted

[4] Based on analytical data from the following sample locations: SB-8 (O'Reilly, Talbot & Okun, 1996), WMW-101, and WMW-102.

[5] Based on analytical data from WMW-101.

[6] All detected concentrations are less than background concentration.

[7] An essential nutrient; non-toxic at these concentrations.

[8] Derived for this evaluation and documented in Appendix D.

[9] Based on analytical data from SB-8 (US Tsubaki, 1996), assumed to be unfiltered.

[10] Based on GC-FID analytical data from SB-8 (US Tsubaki, 1996) and WMW-101.

ACRONYMS:

SQL = Sample Quantitation Limit
EPC = Exposure Point Concentration
Conc. = Concentration
MADEP = Massachusetts Department of Environmental Protection
CPC = Compound of Potential Concern
MCP = Massachusetts Contingency Plan
NBD = No Background Determined
mg/L = milligram per liter
NA - None Available
NE - Not Evaluated because MCP standards not available
GC-FID - Gas Chromatography - Flame Ionization Detector
OHM - Oil or Hazardous Material

TABLE 2-4
METHOD 2 RISK CHARACTERIZATION FOR SOIL
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	Arithmetic Mean of all Samples[1]	EPC[2]	MADEP Background Soil Conc[3]	OHM of Concern?	Notes	MCP S1/GW3 Standards[4] for CPCs	EPC Exceeds MCP Standard?	MCP S3/GW3 Standards[4] for CPCs	EPC Exceeds MCP Standard?
SOIL SAMPLES (mg/kg)													
VOLATILE ORGANIC COMPOUNDS[5]													
1,1,1-Trichloroethane	0.0052 : 3.2	4 / 12	0.016	0.032	0.2945	0.032	NBD	Yes		100	No	500	No
2-Butanone (MEK)	0.01 : 6.3	3 / 12	0.008	0.014	0.5763	0.014	NBD	Yes		40	No	40	No
Acetone	0.011 : 6.1	9 / 12	0.007	1.2	0.4480	0.4480	NBD	Yes		60	No	60	No
Ethylbenzene	0.0052 : 3	2 / 12	1	20	1.8770	1.8770	NBD	Yes		500	No	500	No
Methylene Chloride	0.0052 : 3.2	8 / 12	0.005	0.062	0.3061	0.062	NBD	Yes		100	No	700	No
Tetrachloroethene	0.0052 : 3.2	1 / 12	0.004	0.004	0.2876	0.004	NBD	Yes		200	No	500	No
Toluene	0.0052 : 3	3 / 12	0.001	8.2	0.8371	0.8371	NBD	Yes		500	No	2500	No
Xylenes (total)	0.0052 : 3	2 / 12		3.4	0.4104	0.4104	NBD	Yes		500	No	2500	No
SEMIVOLATILE ORGANIC COMPOUNDS[6]													
bis(2-Ethylhexyl)phthalate		1 / 1	0.083	0.083	0.083	0.083	NBD	Yes		200	No	500	No
INORGANICS[6]													
Barium		1 / 1	19.4	19.4	19.4	19.4	45	No	Background[7]				
Cadmium		1 / 1	0.5	0.5	0.5	0.5	2	No	Background[7]				
Chromium		1 / 1	5.72	5.72	5.72	5.72	29	No	Background[7]				
Lead		1 / 1	1.42	1.42	1.42	1.42	99	No	Background[7]				
OTHER[5,6]													
Tentatively Identified Compounds		5 / 13	0.168	1700	584[8]	1700	NBD	Yes		NA	NE	NA	NE

Notes:

[1] Arithmetic mean of detected concentrations plus 1/2 of SQL for nondetects

[2] The lesser of the arithmetic mean and the maximum detected concentration

[3] From "Guidance for Disposal Site Risk Characterization" (MADEP, 1995)

[4] From 310 CMR 40.0975 (MCP, 1995)

[5] Based on analytical data from the following sample locations: WMW-301, WMW-302, WMW-303, WSB-301, WSB-302, WSB-303, all with one sample taken at 10 ft and one at 20 ft bgs.

[6] Based on analytical data from sample MW-303, taken at 15 ft bgs

[7] All detected concentrations are less than background concentration

[8] Mean of detects. Unable to calculate mean of all samples because no SQL data were available

ACRONYMS:

SQL = Sample Quantitation Limit
EPC = Exposure Point Concentration
Conc. = Concentration
MADEP = Massachusetts Department of Environmental Protection
CPC = Compound of Potential Concern
MCP = Massachusetts Contingency Plan
NBD = No Background Determined
NA = None Available
ft bgs = feet below ground surface
mg/kg = milligram per kilogram
NE - Not evaluated because MCP standards not available
OHM - Oil or Hazardous Material

TABLE 2-5
METHOD 2 RISK CHARACTERIZATION FOR GROUNDWATER
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	EPC[1]	MADEP Background Groundwater Conc[2]	OHM of Concern?	Notes	MCP GW3 Standards[3] for CPCs	EPC Exceeds MCP Standard?
GROUNDWATER SAMPLES (mg/L)										
VOLATILE ORGANIC COMPOUNDS[4]										
1,4-Dichlorobenzene		1 / 35	0.034	0.034	0.034	NBD	Yes		8	No
4-Methyl-2-pentanone	0.01 : 25	1 / 35	0.08	0.08	0.08	NBD	Yes		50	No
Acetone	0.01 : 25	10 / 35	0.01	0.31	0.31	NBD	Yes		50	No
Benzene	0.005 : 12.5	3 / 35	0.001	0.006	0.006	NBD	Yes		7	No
Carbon Disulfide	0.005 : 12.5	1 / 35	0.006	0.006	0.006	NBD	No	Frequency[5]		
Ethylbenzene	0.005 : 12.5	15 / 35	0.008	1	1	NBD	Yes		4	No
Methylene chloride	0.005 : 12.5	5 / 35	0.006	0.086	0.086	NBD	Yes		50	No
Toluene	0.005 : 12.5	2 / 35	0.008	0.011	0.011	NBD	Yes		50	No
Total Xylenes	0.005 : 2	16 / 35	0.001	5.7	5.7	NBD	Yes		50	No
Trichloroethene	0.005 : 12.5	4 / 35	0.003	0.031	0.031	NBD	Yes		20	No
SEMIVOLATILE ORGANIC COMPOUNDS[4]										
2,4-Dimethylphenol	0.01 : 0.04	3 / 19	0.004	0.008	0.008	NBD	Yes		20	No
2-Methylnaphthalene	0.01 : 0.01	12 / 19	0.003	0.068	0.068	NBD	Yes		3	No
4-Methylphenol	0.01 : 0.04	2 / 19	0.001	0.009	0.009	NBD	Yes		1.46[10]	No
Naphthalene	0.01 : 0.01	10 / 19	0.002	0.096	0.096	NBD	Yes		6	No
bis(2-Ethylhexyl)phthalate	0.01 : 0.018	2 / 6	0.001	0.002	0.002	NBD	Yes		0.03	No
DISSOLVED INORGANICS[6]										
Iron		1 / 1	5.34	5.34	5.34	NBD	Yes		967[10]	No
Manganese		1 / 1	0.0522	0.0522	0.0522	NBD	Yes		2.8[10]	No
Mercury		1 / 1	0.00085	0.00085	0.00085	0.00095	No	Background[7]		
Sodium		1 / 1	8.03	8.03	8.03	NBD	No	Nutrient[8]		
TOTAL INORGANICS[9]										
Calcium		2 / 2	8.4	9.5	9.5	NBD	No	Nutrient[8]		
Iron		2 / 2	28.6	136	136	NBD	Yes		967[10]	No
Manganese		2 / 2	0.12	0.21	0.21	NBD	Yes		2.8[10]	No
Sodium		2 / 2	5.4	8.5	8.5	NBD	No	Nutrient[8]		
OTHER										
Total Petroleum Hydrocarbons[11]		2 / 4	6	9	9	NBD	Yes		50	No
Tentatively Identified Compounds[4]		9 / 35	0.162	1.983	1.983	NBD	Yes		NA	NE

Notes:
[1] The maximum detected concentration or, if the maximum exceeds the standard, the mean concentration of compound in well where exceedance was detected
[2] From "Guidance for Disposal Site Risk Characterization" (MADEP, 1995)
[3] From 310 CMR 40.0975 (MCP, 1995), unless otherwise noted
[4] Based on analytical data from the following sample locations: WMW-301, WMW-302, WMW-303,WMW-304, WMW-304A, WMW-305, WMW305I, WMW-306, WMW-307, WMW-308I, WMW-5D.
[5] Compound detected in fewer than 5% of samples
[6] Based on analytical data from WMW-303.
[7] Analyte is an essential human nutrient
[8] An essential nutrient; non-toxic at these concentrations
[9] Based on analytical data from wells WMW-301 and WMW-302.
[10] Derived for this evaluation and documented in Appendix D.
[11] Based on IR analytical data from wells WMW-302, WMW-304A, WMW305I, and WMW-307.

ACRONYMS:
SQL = Sample Quantitation Limit
EPC = Exposure Point Concentration
Conc. = Concentration
MADEP = Massachusetts Department of Environmental Protecti
CPC = Compound of Potential Concern
MCP = Massachusetts Contingency Plan
NBD = No Background Determined
NA - None Available
mg/L = milligram per liter
NE - Not Evaluated because MCP standards not available
IR - Infared Spectrometry
OHM - Oil or Hazardous Material

TABLE 2-6
METHOD 2 RISK CHARACTERIZATION FOR SOIL
PUMPHOUSE NO. 8

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	Arithmetic Mean of all Samples[1]	EPC[2]	MADEP Background Soil Conc[3]	OHM of Concern?	Notes	MCP S1/GW3 Standards[4] for CPCs	EPC Exceeds MCP Standard?	MCP S3/GW3 Standards[4] for CPCs	EPC Exceeds MCP Standard?
SOIL SAMPLES (mg/kg)													
VOLATILE ORGANIC COMPOUNDS[5]													
1,1,1-Trichloroethane	0.0052 : 62	2 / 16	0.002	0.003	3.1992	0.003	NBD	Yes		100	No	500	No
Acetone	0.01 : 62	11 / 16	0.013	51	5.7242	5.7242	NBD	Yes		60	No	60	No
Ethylbenzene	0.0052 : 6.3	2 / 16	23	120	9.2305	9.2305	NBD	Yes		500	No	500	No
Methylene Chloride	0.0052 : 62	12 / 16	0.003	250	17.8596	17.8596	NBD	Yes		100	No	700	No
Toluene	0.0052 : 6.3	2 / 16	8.4	100	7.0680	7.0680	NBD	Yes		500	No	2500	No
Xylenes (total)	0.0052 : 6.3	3 / 16	1.9	630	49.0677	49.0677	NBD	Yes		500	No	2500	No
SEMIVOLATILE ORGANIC COMPOUNDS[6]													
2-Methylnaphthalene		1 / 1	2.8	2.8	2.8	2.8	NBD	Yes		7	No	7	No
Naphthalene		1 / 1	2	2	2	2	NBD	Yes		100	No	1000	No
bis(2-Ethylhexyl)phthalate		1 / 1	0.17	0.17	0.17	0.17	NBD	Yes		200	No	500	No
INORGANICS[7]													
Barium		1 / 1	22.1	22.1	22.1	22.1	45	No	Background[8]				
Cadmium		1 / 1	0.47	0.47	0.47	0.47	2	No	Background[8]				
Chromium		1 / 1	5.09	5.09	5.09	5.09	29	No	Background[8]				
Mercury		1 / 1	0.19	0.19	0.19	0.19	0.3	No	Background[8]				
OTHER													
Total Petroleum Hydrocarbons (0-15 ft bgs)[10]		6 / 6	5.2	16	11.2	11.2	NBD	Yes		500	No	5000	No
Total Petroleum Hydrocarbons (>15 ft bgs)[11]		25 / 26	5.6	12000	1073	1073	NBD	Yes		–		5000	No
Tentatively Identified Compounds[5,6]		4 / 16	241	4400	1305[9]	4400	NBD	Yes		NA	NE	NA	NE

Notes:

[1] Arithmetic mean of detected concentrations plus 1/2 of SQL for nondetects.

[2] The lesser of the arithmetic mean and the maximum detected concentration.

[3] From "Guidance for Disposal Site Risk Characterization" (MADEP, 1995).

[4] From 310 CMR 40.0975 (MCP, 1995).

[5] Based on analytical data from the following sample locations: MWW-401, MWW-402, MWW-403, WSB-401, WSB-402, WSB-403, WSB-404, WSB-405, all with one sample taken at 10 ft and one at 20 ft bgs.

[6] Based on analytical data from sample MWW-401, taken at 20 ft bgs.

[7] Based on analytical data from sample MWW-402, taken at 20 ft bgs.

[8] All detected concentrations are less than background concentration.

[9] Mean of detects. Unable to calculate mean of all samples because no SQL data were available.

[10] Based on analytical data from sample interval S-1, taken at 14 ft. bgs from borings B-1 through B-6 (Tighe & Bond, 1991).

[11] Based on analytical data from sample intervals S-2 through S-5, taken at 16, 18, 20 and 22 ft. bgs, respectively, from borings B-1 through B-6. At borings B-2 and B-4, S-2 is separated into S-2A at 16 ft bgs and S-2B at 17 ft bgs (Tighe & Bond, 1991).

ACRONYMS:

SQL = Sample Quantitation Limit
EPC = Exposure Point Concentration
Conc. = Concentration
MADEP = Massachusetts Department of Environmental Protection
CPC = Compound of Potential Concern
MCP = Massachusetts Contingency Plan
NBD = No Background Determined
NA = None Available
ft bgs = feet below ground surface
mg/kg = milligram per kilogram
NE - Not evaluated because MCP standards not available
OHM - Oil or Hazardous Material
– -Deeper samples not compared to S1/GW3 standards because of lack of accessibility

TABLE 2-7
METHOD 2 RISK CHARACTERIZATION FOR GROUNDWATER
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	EPC[1]	MADEP Background Groundwater Conc.[2]	OHM of Concern?	Notes	MCP GW3 Standards[3] for CPCs	EPC Exceeds MCP Standard?
GROUNDWATER SAMPLES (mg/L)										
VOLATILE ORGANIC COMPOUNDS[4]										
Acetone	0.01 : 25	4 / 41	0.002	0.23	0.23	NBD	Yes		50	No
Benzene	0.005 : 12.5	3 / 41	0.018	0.08	0.08	NBD	Yes		7	No
Chloroform	0.005 : 12.5	1 / 41	0.006	0.006	0.006	NBD	Yes		10	No
Ethylbenzene	0.005 : 0.01	23 / 41	0.001	1.8	1.8	NBD	Yes		4	No
Methylene chloride	0.005 : 12.5	8 / 41	0.004	1.3	1.3	NBD	Yes		50	No
Toluene	0.005 : 12.5	14 / 41	0.0005	3	3	NBD	Yes		50	No
Total Xylenes	0.005 : 0.02	23 / 41	0.005	14	14	NBD	Yes		50	No
SEMIVOLATILE ORGANIC COMPOUNDS[4]										
2,4-Dimethylphenol	0.01 : 1	2 / 16	0.004	0.007	0.007	NBD	Yes		20	No
2-Methylnaphthalene	0.01 : 0.01	13 / 16	0.006	0.5	0.5	NBD	Yes		3	No
2-Methylphenol	0.01 : 1	1 / 16	0.011	0.011	0.011	NBD	Yes		1.31 [9]	No
4-Methylphenol	0.01 : 1	5 / 16	0.001	0.008	0.008	NBD	Yes		1.46 [9]	No
Acenaphthene	0.01 : 0.01	3 / 5	0.001	0.002	0.002	NBD	Yes		2	No
Bis(2-ethylhexyl)phthalate	0.01 : 1	6 / 16	0.002	0.039	0.01225 [5]	NBD	Yes		0.03	No
Dibenzofuran	0.01 : 0.01	1 / 5	0.001	0.001	0.001	NBD	Yes		2130	No
Fluorene	0.01 : 0.01	2 / 5	0.001	0.001	0.001	NBD	Yes		1	No
Naphthalene	0.01 : 0.01	12 / 16	0.003	0.36	0.36	NBD	Yes		6	No
Phenanthrene	0.01 : 0.01	2 / 5	0.001	0.001	0.001	NBD	Yes		0.05	No
DISSOLVED INORGANICS[6]										
Iron		1 / 1	26.8	26.8	26.8	NBD	Yes		967 [9]	No
Manganese		1 / 1	0.677	0.677	0.677	NBD	Yes		2.8 [9]	No
Mercury		1 / 1	0.00075	0.00075	0.00075	0.00095	No	Background[7]		
Sodium		1 / 1	29.8	29.8	29.8	NBD	No	Nutrient[8]		
TOTAL INORGANICS[10]										
Calcium		2 / 2	7.2	12	12	NBD	No	Nutrient[8]		
Iron		2 / 2	9.9	32.4	32.4	NBD	Yes		967 [9]	No
Manganese		2 / 2	0.15	0.24	0.24	NBD	Yes		2.8 [9]	No
Sodium		2 / 2	6	15.1	15.1	NBD	No	Nutrient[8]		
OTHER										
Total Petroleum Hydrocarbon [11]		5 / 6	1	7	7	NBD	Yes		50	No
Tentatively Identified Compounds [4]		9 / 41	0.051	10.62	10.62	NBD	Yes		NA	NE

Notes:
[1] The maximum detected concentration or, if the maximum exceeds the standard, the mean concentration of compound in well where exceedance was detected
[2] From "Guidance for Disposal Site Risk Characterization" (MADEP, 1995)
[3] From 310 CMR 40.0975 (MCP, 1995), unless otherwise noted
[4] Based on analytical data from the following sample locations: WMW-401, WMW-402, WMW-403, WMW-404, WMW-405, WMW-406, WMW-406I, WMW407I, WMW-408I, WMW409I, and WMW-410D.
[5] Temporal mean concentration in WMW-406I
[6] Based on analytical data from WMW-402.
7 Maximum conentration less than background concentration.
[8] An essential nutrient; non-toxic at these concentrations.
[9] Derived for this evaluation and documented in Appendix D.
[10] Based on analytical data from wells WMW-402 and WMW406I.
[11] Based on IR analytical data from WMW-402, WMW-406, WMW-407I, WMW-408I, WMW410D.

ACRONYMS:
SQL = Sample Quantitation Limit
EPC = Exposure Point Concentration
Conc. = Concentration
MADEP = Massachusetts Department of Environmental Protection
CPC = Compound of Potential Concern
MCP = Massachusetts Contingency Plan
NBD = No Background Determined
NA - None Available
mg/L = milligram per liter
NE - Not Evaluated because MCP standards not available
IR - Infared Spectrometry
OHM - Oil or Hazardous Material

TABLE 2-8
METHOD 2 RISK CHARACTERIZATION FOR SOIL
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	Arithmetic Mean of all Samples[1]	EPC[2]	MADEP Background Soil Conc[3]	OHM of Concern?	Notes	MCP S1/GW3 Standards[4] for CPCs	EPC Exceeds MCP Standard?	MCP S3/GW3 Standards[4] for CPCs	EPC Exceeds MCP Standard?
SOIL SAMPLES (mg/kg)													
VOLATILE ORGANIC COMPOUNDS[5]													
4-Methyl-2-pentanone	0.01 : 6.1	1 / 20	3.3	3.3	0.4219	0.4219	NBD	Yes		70	No	70	No
Acetone	0.01 : 6.1	10 / 20	0.007	0.88	0.3086	0.3086	NBD	Yes		60	No	60	No
Benzene	0.0052 : 3	1 / 20	0.032	0.032	0.1421	0.032	NBD	Yes		40	No	200	No
Ethylbenzene	0.0052 : 1.3	6 / 20	0.002	9.2	0.6313	0.6313	NBD	Yes		500	No	500	No
Methylene Chloride	0.0052 : 3	10 / 20	0.004	2.3	0.2583	0.2583	NBD	Yes		100	No	700	No
Toluene	0.0052 : 1.3	11 / 20	0.001	4.9	0.4053	0.4053	NBD	Yes		500	No	2500	No
Xylenes (total)	0.0052 : 0.0089	8 / 20	0.009	30	2.7203	2.7203	NBD	Yes		500	No	2500	No
SEMIVOLATILE ORGANIC COMPOUNDS[6]													
bis(2-Ethylhexyl)phthalate		1 / 1	0.076	0.076	0.076	0.076	NBD	Yes		200	No	500	No
INORGANICS[6]													
Arsenic		1 / 1	1.84	1.84	1.84	1.84	17	No	Background[7]				
Barium		1 / 1	22.8	22.8	22.8	22.8	45	No	Background[7]				
Cadmium		1 / 1	0.57	0.57	0.57	0.57	2	No	Background[7]				
Chromium		1 / 1	6.12	6.12	6.12	6.12	29	No	Background[7]				
OTHER[5,6]													
Tentatively Identified Compounds		6 / 21	0.037	410	91[8]	410	NBD	Yes		NA	NE	NA	NE

Notes:

[1] Arithmetic mean of detected concentrations plus 1/2 of SQL for nondetects

[2] The lesser of the arithmetic mean and the maximum detected concentration

[3] From "Guidance for Disposal Site Risk Characterization" (MADEP, 1995)

[4] From 310 CMR 40.0975 (MCP, 1995)

[5] Based on analytical data from the following sample locations: WMW-501, WMW-502, WMW-503, WSB-501, WSB-502, WSB-503, and WSB-513, all with one sample taken at 10 ft and one at 20 ft bgs; WSB-511 with one sample taken at 20 ft. bgs; WSB-512 with one sample taken at 1.5 ft and one at 20 ft bgs; and WSB-510 with one sample each taken at 1.5, 15 and 20 ft bgs.

[6] Based on analytical data from sample MW-503, taken at 15 ft bgs

[7] All detected concentrations are less than background concentration

[8] Mean of detects. Unable to calculate mean of all samples because no SQL data were available

ACRONYMS:

SQL = Sample Quantitation Limit
EPC = Exposure Point Concentration
ft bgs = feet below ground surface
Conc. = Concentration
MADEP = Massachusetts Department of Environmental Protection
CPC = Compound of Potential Concern
MCP = Massachusetts Contingency Plan
NBD = No Background Determined
NA = None Available
mg/kg = milligram per kilogram
NE - Not evaluated because MCP standards not available
OHM - Oil or Hazardous Material

TABLE 2-9
METHOD 2 RISK CHARACTERIZATION FOR GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	EPC[1]	MADEP Background Groundwate Conc[2]	OHM of Concern?	Notes	MCP GW3 Standards[3] for CPCs	EPC Exceeds MCP Standard?
GROUNDWATER SAMPLES (mg/L)										
VOLATILE ORGANIC COMPOUNDS[4]										
Acetone	0.01 : 2.5	7 / 43	0.001	0.46	0.46	NBD	Yes		50	No
Benzene	0.005 : 50	13 / 43	0.002	1.8	1.8	NBD	Yes		7	No
Ethylbenzene	0.005 : 200	27 / 43	0.0011	1.8	1.8	NBD	Yes		4	No
Methylene chloride	0.005 : 50	6 / 43	0.0073	0.00063	0.00063	NBD	Yes		50	No
Toluene	0.005 : 2	19 / 43	0.0005	0.013	0.013	NBD	Yes		50	No
Total Xylenes	0.005 : 0.011	27 / 43	0.0008	0.0041	0.0041	NBD	Yes		50	No
SEMIVOLATILE ORGANIC COMPOUNDS[4]										
2,4-Dimethylphenol	0.01 : 0.04	8 / 20	0.002	0.061	0.061	NBD	Yes		20	No
2-Methylnaphthalene	0.01 : 0.04	10 / 20	0.014	0.074	0.074	NBD	Yes		3	No
2-Methylphenol	0.01 : 0.04	3 / 20	0.007	0.094	0.094	NBD	Yes		1.31[9]	No
4-Methylphenol	0.01 : 0.04	5 / 20	0.002	0.068	0.068	NBD	Yes		1.46[9]	No
Benzo(b)Fluoranthene	0.01 : 0.02	1 / 7	0.002	0.002	0.002	NBD	Yes		0.007	No
Benzyl Alcohol	0.01 : 0.04	1 / 13	0.075	0.075	0.075	NBD	Yes		10[9]	No
Bis(2-ethylhexyl)phthalate	0.01 : 0.04	4 / 20	0.002	0.025	0.025	NBD	Yes		0.03	No
Fluoranthene	0.01 : 0.02	1 / 7	0.001	0.001	0.001	NBD	Yes		0.1	No
Naphthalene	0.01 : 0.01	14 / 20	0.002	0.15	0.15	NBD	Yes		6	No
Phenanthrene	0.01 : 0.02	1 / 7	0.002	0.002	0.002	NBD	Yes		0.05	No
Phenol	0.01 : 0.04	2 / 20	0.005	0.01	0.01	NBD	Yes		30	No
Pyrene	0.01 : 0.02	1 / 7	0.001	0.001	0.001	NBD	Yes		0.08	No
DISSOLVED INORGANICS[5]										
Iron		1 / 1	11.5	11.5	11.5	NBD	Yes		967[9]	No
Manganese		1 / 1	0.113	0.113	0.113	NBD	Yes		2.8[9]	No
Mercury		1 / 1	0.00075	0.00075	0.00075	0.00095	No	Background[6]		
TOTAL INORGANICS[7]										
Calcium		2 / 2	7.2	8.2	8.2	NBD	No	Nutrient[8]		
Iron		2 / 2	19.4	23.5	23.5	NBD	Yes		967[9]	No
Manganese		2 / 2	0.12	0.5	0.5	NBD	Yes		2.8[9]	No
Sodium		2 / 2	2	5	5	NBD	No	Nutrient[8]		
OTHER										
Total Petroleum Hydrocarbon[10]		3 / 7	1	16	16	NBD	Yes		50	No
Tentatively Identified Compounds[4]		6 / 43	0.51	2.5	2.5	NBD	Yes		NA	NE

Notes:
[1] The maximum detected concentration or, if the maximum exceeds the standard, the mean concentration of compound in well where exceedance was detected
[2] From "Guidance for Disposal Site Risk Characterization" (MADEP, 1995)
[3] From 310 CMR 40.0975 (MCP, 1995), unless otherwise noted
[4] Based on analytical data from the following sample locations: WMW-501, WMW-502, WMW-503, WMW-504, WMW-505, WMW-506, WMW506I, WMW-507, WMW-508, WMW-509D, WMW-510I
[5] Based on analytical data from WMW-501.
[6] All detected concentrations are less than background concentration
[7] Based on analytical data from WMW-501 and WMW-504
[8] An essential nutrient; non-toxic at these concentrations
[9] Derived for this evaluation and documented in Appendix D.
[10] Based on IR analytical data from WMW-501 , WMW-502, WMW-504, WMW-506I, WMW-507, WMW-508, WMW-509D.

ACRONYMS:
SQL = Sample Quantitation Limit
EPC = Exposure Point Concentration
Conc. = Concentration
MADEP = Massachusetts Department of Environmental Protect
CPC = Compound of Potential Concern
MCP = Massachusetts Contingency Plan
NBD = No Background Determined
NA - None Available
NE - Not Evaluated because MCP standards not available
mg/L = milligram per liter
IR - Infared Spectrometry
OHM - Oil or Hazardous Material

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER AND SOIL DURING ABB-ES AND GZA INVESTIGATIONS

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 1

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION / DATE SAMPLED	WMW-101 2/6/89	WMW-101 7/10/95	WMW-102 2/6/89	WMW-102 3/4/94
Volatile Organic Compounds (8020) - µg/l				
1,1-Dichloroethane	-	-	-	-
1,2-Dichloroethane	-	-	-	-
1,4-Dichlorobenzene	-	-	-	-
2-Butanone	-	-	-	-
2-Hexanone	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	-
Acetone	7 JB	-	16 B	-
Benzene	-	-	-	-
Carbon Disulfide	-	-	-	-
Chloroform	-	-	-	-
Ethylbenzene	-	400	-	99
Methylene chloride	2 J	-	-	-
Tetrachloroethene	-	-	-	-
Toluene	3 J	300	-	120
Total Xylenes	17	1400	2 J	480
Trichloroethene	-	-	-	-
Unknown	-	-	-	-
Unknown Cyclic Hydrocarbon	15	-	-	-
Unknown Hydrocarbon	24	-	-	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 1

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-101 2/6/89	WMW-101 7/10/95	WMW-102 2/6/89	WMW-102 3/4/94
Semivolatile Organic Compounds (8270) - µg/l				
2,4-Dichlorophenol	-	-	-	-
2,4-Dimethylphenol	-	-	-	-
2-Methylnaphthalene	-	-	-	-
2-Methylphenol	-	-	-	-
4-Methylphenol	-	-	-	-
Acenaphthene	-	-	-	-
Anthracene	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-
Benzyl Alcohol	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-
Di-n-octylphthalate	-	-	-	-
Dibenzofuran	-	-	-	-
Diethylphthalate	-	-	-	-
Dimethylphthalate	-	-	-	-
Fluoranthene	-	-	-	-
Hexachloroethane	-	-	-	-
Fluorene	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-
Naphthalene	-	-	-	-
Phenanthrene	-	-	-	-
Phenol	-	-	-	-
Pyrene	-	-	-	-
Unknown	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-
Unknown Hydrocarbon	-	-	-	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION / DATE SAMPLED	WMW-301 * 7/13/95	WMW-301 2/6/89	WMW-301 5/19/92	WMW-301 3/9/94	WMW-301 9/22/94	WMW-301 7/13/95	WMW-302 2/6/89	WMW-302 5/19/92	WMW-302 3/9/94
Volatile Organic Compounds (8020) - µg/l									
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA	NA	NA	NA
Unknown	NA	NA	NA	NA	NA	NA	NA	NA	NA
Unknown Hydrocarbon	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (8240) - µg/l									
1,1-Dichloroethane	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	-	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-	-
2-Hexanone	-	-	-	-	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	-	-	-	-	-	-
Acetone	-	51 B	-	-	-	-	310 JB	-	-
Benzene	-	-	-	-	-	-	-	-	-
Carbon Disulfide	-	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-	-
Ethylbenzene	640	-	-	730	280	620	-	410	980
Methylene chloride	-	-	-	-	-	-	55 JB	86	-
Tetrachloroethene	-	-	-	-	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-	-
Total Xylenes	2300	1970	-	2700	1000	2200	5700	1300	2800
Trichloroethene	-	-	-	-	-	-	-	-	-
Unknown	-	40	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	400	-	-	61	-	600	-	-
Unknown Hydrocarbon	-	890	-	-	1540	-	1300	-	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-301 * 7/13/95	WMW-301 2/6/89	WMW-301 5/19/92	WMW-301 3/9/94	WMW-301 9/22/94	WMW-301 7/13/95	WMW-302 2/6/89	WMW-302 5/19/92	WMW-302 3/9/94
Semivolatile Organic Compounds (8270) - µg/l									
2,4-Dichlorophenol	-	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	8 J	-	-	-	-	7 J	-	-	-
2-Methylnaphthalene	-	-	36	-	-	-	-	21	68
2-Methylphenol	-	-	-	-	-	-	-	-	-
4-Methylphenol	1 J	-	-	-	-	2 J	-	-	-
Acenaphthene	-	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	-	-	-	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	62	-	-	-	-	36	96
Phenanthrene	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-	-	-
Total Petroleum Hydrocarbon	NA	NA	NA	NA	NA	NA	NA	-	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-302	WMW-302	WMW-302 *	WMW-303	WMW-303	WMW-303	WMW-303	WMW-303	WMW-304A
DATE SAMPLED	9/22/94	7/13/95	3/9/94	2/6/89	1/28/93	3/9/94	9/22/94	7/12/95	5/20/92
Volatile Organic Compounds (8020) - µg/l									
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA	NA	NA	NA
Unknown	NA	NA	NA	NA	NA	NA	NA	NA	NA
Unknown Hydrocarbon	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (8240) - µg/l									
1,1-Dichloroethane	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	-	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-	-
2-Hexanone	-	-	-	-	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	80	-	-	-	-	-
Acetone	-	-	-	-	-	-	-	-	13
Benzene	-	-	-	-	-	-	-	-	-
Carbon Disulfide	-	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-	-
Ethylbenzene	200	450	1000	-	11	170	130	8	-
Methylene chloride	-	-	-	6 J	8.2 B	-	-	-	-
Tetrachloroethene	-	-	-	-	-	-	-	-	-
Toluene	-	-	-	8 J	-	-	-	-	-
Total Xylenes	820	1200	2900	282	39	590	400	24	-
Trichloroethene	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	400	-	-	47	-	-
Unknown Cyclic Hydrocarbon	32	-	-	400	-	-	71	-	-
Unknown Hydrocarbon	1060	-	-	800	-	-	857	-	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-302	WMW-302	WMW-302 *	WMW-303	WMW-303	WMW-303	WMW-303	WMW-303	WMW-304A
DATE SAMPLED	9/22/94	7/13/95	3/9/94	2/6/89	1/28/93	3/9/94	9/22/94	7/12/95	5/20/92
Semivolatile Organic Compounds (8270) - µg/l									
2,4-Dichlorophenol	-	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	4 J	-	4 J	-	-	-	-	-
2-Methylnaphthalene	-	-	-	-	-	34	-	16	-
2-Methylphenol	-	-	-	-	-	-	-	-	-
4-Methylphenol	-	9 J	-	-	-	-	-	-	-
Acenaphthene	-	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	-	-	-	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	2 J	-	19	-	12	-
Phenanthrene	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	800	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	50	-	-	-	-	-
Total Petroleum Hydrocarbon	NA	NA	NA	NA	NA	NA	NA	NA	6000

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-304A	WMW-304A*	WMW-305	WMW-305	WMW-305	WMW-305I	WMW-305I	WMW-305I	WMW-305I
DATE SAMPLED	3/24/94	5/20/92	12/5/89	3/9/94	7/12/95	5/20/92	3/9/94	9/20/94	7/12/95
Volatile Organic Compounds (8020) - µg/l									
1,4-Dichlorobenzene	NA	NA	-	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	-	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	-	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	-	NA	NA	NA	NA	NA	NA
Unknown	NA	NA	-	NA	NA	NA	NA	NA	NA
Unknown Hydrocarbon	NA	NA	-	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (8240) - µg/l									
1,1-Dichloroethane	-	-	NA	-	-	-	-	-	-
1,2-Dichloroethane	-	-	NA	-	-	-	-	-	-
1,4-Dichlorobenzene	-	-	NA	-	-	-	-	-	-
2-Butanone	-	-	NA	-	-	-	-	-	-
2-Hexanone	-	-	NA	-	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	NA	-	-	-	-	-	-
Acetone	10	-	NA	-	-	-	23	-	-
Benzene	-	-	NA	-	-	-	-	-	-
Carbon Disulfide	-	-	NA	-	-	-	-	-	-
Chloroform	-	-	NA	-	-	-	-	-	-
Ethylbenzene	-	-	NA	-	-	-	-	-	-
Methylene chloride	-	-	NA	-	-	-	-	-	-
Tetrachloroethene	-	-	NA	-	-	-	-	-	-
Toluene	-	-	NA	-	-	-	-	-	-
Total Xylenes	-	-	NA	-	1 J	-	-	-	-
Trichloroethene	-	-	NA	-	-	-	-	-	-
Unknown	-	-	NA	-	-	-	-	10	-
Unknown Cyclic Hydrocarbon	-	-	NA	-	-	-	-	37	-
Unknown Hydrocarbon	-	-	NA	-	-	-	-	115	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-304A	WMW-304A*	WMW-305	WMW-305	WMW-305	WMW-305I	WMW-305I	WMW-305I	WMW-305I
DATE SAMPLED	3/24/94	5/20/92	12/5/89	3/9/94	7/12/95	5/20/92	3/9/94	9/20/94	7/12/95
Semivolatile Organic Compounds (8270) - µg/l									
2,4-Dichlorophenol	-	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	-	-	-	-	-	-	-	-
2-Methylnaphthalene	-	-	-	-	-	-	11	-	10
2-Methylphenol	-	-	-	-	-	-	-	-	-
4-Methylphenol	-	-	-	-	-	-	-	-	-
Acenaphthene	-	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	-	-	-	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	-	-	-
Phenanthrene	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-	-	-
Total Petroleum Hydrocarbon	NA	6000	NA	NA	NA	-	NA	NA	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-306	WMW-306	WMW-306	WMW-307 *	WMW-307	WMW-307	WMW-307	WMW-307
DATE SAMPLED	12/5/89	3/11/94	7/13/95	7/12/95	5/20/92	3/11/94	9/20/94	7/12/95
Volatile Organic Compounds (8020) - µg/l								
1,4-Dichlorobenzene	-	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	-	NA	NA	NA	NA	NA	NA	NA
Toluene	-	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	-	NA	NA	NA	NA	NA	NA	NA
Unknown	-	NA	NA	NA	NA	NA	NA	NA
Unknown Hydrocarbon	-	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (8240) - µg/l								
1,1-Dichloroethane	NA	-	-	-	-	-	-	-
1,2-Dichloroethane	NA	-	-	-	-	-	-	-
1,4-Dichlorobenzene	NA	-	-	-	-	-	-	-
2-Butanone	NA	-	-	-	-	-	-	-
2-Hexanone	NA	-	-	-	-	-	-	-
4-Methyl-2-Pentanone	NA	-	-	45 J	-	-	-	-
Acetone	NA	-	-	-	14	-	100	-
Benzene	NA	-	-	-	-	-	-	-
Carbon Disulfide	NA	-	-	-	6	-	-	-
Chloroform	NA	-	-	-	-	-	-	-
Ethylbenzene	NA	-	-	-	-	-	-	-
Methylene chloride	NA	-	-	-	-	-	-	-
Tetrachloroethene	NA	-	-	-	-	-	-	-
Toluene	NA	-	-	-	-	-	-	-
Total Xylenes	NA	-	-	-	-	-	-	30 J
Trichloroethene	NA	-	-	-	-	-	-	-
Unknown	NA	-	-	-	-	-	660	-
Unknown Cyclic Hydrocarbon	NA	-	-	-	-	-	-	-
Unknown Hydrocarbon	NA	-	-	-	-	-	1983	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-306	WMW-306	WMW-306	WMW-307 *	WMW-307	WMW-307	WMW-307	WMW-307
DATE SAMPLED	12/5/89	3/11/94	7/13/95	7/12/95	5/20/92	3/11/94	9/20/94	7/12/95
Semivolatile Organic								
Compounds (8270) - µg/l								
2,4-Dichlorophenol	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	-	-	-	-	-	-	-
2-Methylnaphthalene	-	14	3 J	-	-	-	-	-
2-Methylphenol	-	-	-	-	-	-	-	-
4-Methylphenol	-	-	-	-	-	-	-	-
Acenaphthene	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	1 J	-	-	-	-	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-
Naphthalene	-	30	-	-	-	-	-	-
Phenanthrene	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-	-
Total Petroleum Hydrocarbon	NA	NA	NA	NA	9000	NA	NA	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-401	WMW-401	WMW-402	WMW-402	WMW-402	WMW-402	WMW-402	WMW-402 *	WMW-404
DATE SAMPLED	2/7/89	1/28/93	2/7/89	5/19/92	3/4/94	9/23/94	7/14/95	9/23/94	12/4/89
Volatile Organic Compounds (8020) - µg/l									
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	-	-
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	-	-
Toluene	NA	NA	NA	NA	NA	NA	NA	-	0.6 J
Total Xylenes	NA	NA	NA	NA	NA	NA	NA	-	-
Unknown	NA	NA	NA	NA	NA	NA	NA	490	-
Unknown Hydrocarbon	NA	NA	NA	NA	NA	NA	NA	5280	-
Volatile Organic Compounds (8240) - µg/l									
1,1-Dichloroethane	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	-	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-	-
2-Hexanone	-	-	-	-	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	-	-	-	-	-	-
Acetone	-	-	230 J	-	-	-	-	-	-
Benzene	-	-	80 J	-	-	-	-	-	-
Carbon Disulfide	-	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	1100	1800	1600	1100	1300	980	-
Methylene chloride	4 JB	8.2 B	1300 B	-	-	-	-	-	-
Tetrachloroethene	-	-	-	-	-	-	-	-	-
Toluene	2 J	-	3000	2400	690	340 J	180	290 J	-
Total Xylenes	5 J	-	9000	8900	8100	6900	14000	5700	-
Trichloroethene	-	-	-	-	-	-	-	-	-
Unknown	-	-	300	-	-	720	-	-	-
Unknown Cyclic Hydrocarbon	-	-	600	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	800	-	-	9900	-	-	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-401 2/7/89	WMW-401 1/28/93	WMW-402 2/7/89	WMW-402 5/19/92	WMW-402 3/4/94	WMW-402 9/23/94	WMW-402 7/14/95	WMW-402 * 9/23/94	WMW-404 12/4/89
Semivolatile Organic Compounds (8270) - µg/l									
2,4-Dichlorophenol	-	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	-	7 J	-	-	-	-	-	-
2-Methylnaphthalene	-	-	130	53	500	-	6 J	-	-
2-Methylphenol	-	-	-	11	-	-	-	-	-
4-Methylphenol	-	-	8 J	-	-	-	5 J	-	-
Acenaphthene	-	-	-	-	-	-	2 J	-	-
Anthracene	-	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	-	8 J	-	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	1 J	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	240	130	360	-	6 J	-	-
Phenanthrene	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-	-
Unknown	-	-	3600	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-	-	-
Total Petroleum Hydrocarbon	NA	NA	NA	4000	NA	NA	NA	NA	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-404	WMW-404	WMW-404	WMW-405	WMW-405	WMW-405	WMW-405	WMW-406	WMW-406
DATE SAMPLED	1/28/93	3/4/94	7/14/95	12/4/89	1/28/93	3/7/94	7/14/95	12/5/89	5/19/92
Volatile Organic Compounds (8020) - µg/l									
1,4-Dichlorobenzene	NA	NA	NA	-	NA	NA	NA	-	NA
Ethylbenzene	NA	NA	NA	-	NA	NA	NA	-	NA
Toluene	NA	NA	NA	0.5 J	NA	NA	NA	140	NA
Total Xylenes	NA	NA	NA	-	NA	NA	NA	18	NA
Unknown	NA	NA	NA	-	NA	NA	NA	-	NA
Unknown Hydrocarbon	NA	NA	NA	-	NA	NA	NA	-	NA
Volatile Organic Compounds (8240) - µg/l									
1,1-Dichloroethane	-	-	-	NA	-	-	-	NA	-
1,2-Dichloroethane	-	-	-	NA	-	-	-	NA	-
1,4-Dichlorobenzene	-	-	-	NA	-	-	-	NA	-
2-Butanone	-	-	-	NA	-	-	-	NA	-
2-Hexanone	-	-	-	NA	-	-	-	NA	-
4-Methyl-2-Pentanone	-	-	-	NA	-	-	-	NA	-
Acetone	-	-	2 J	NA	-	-	-	NA	-
Benzene	-	-	-	NA	-	-	-	NA	-
Carbon Disulfide	-	-	-	NA	-	-	-	NA	-
Chloroform	-	-	-	NA	-	-	-	NA	-
Ethylbenzene	-	-	-	NA	-	40	21	NA	330
Methylene chloride	8 B	-	-	NA	7.9 B	-	-	NA	40
Tetrachloroethene	-	-	-	NA	-	-	-	NA	-
Toluene	-	-	-	NA	-	-	-	NA	-
Total Xylenes	-	-	-	NA	10	34	-	NA	1700
Trichloroethene	-	-	-	NA	-	-	-	NA	-
Unknown	-	-	-	NA	-	-	-	NA	-
Unknown Cyclic Hydrocarbon	-	-	-	NA	-	-	-	NA	-
Unknown Hydrocarbon	-	-	-	NA	-	-	-	NA	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-404	WMW-404	WMW-404	WMW-405	WMW-405	WMW-405	WMW-405	WMW-406	WMW-406
DATE SAMPLED	1/28/93	3/4/94	7/14/95	12/4/89	1/28/93	3/7/94	7/14/95	12/5/89	5/19/92
Semivolatile Organic Compounds (8270) - µg/l									
2,4-Dichlorophenol	-	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	-	-	-	-	-	-	-	-
2-Methylnaphthalene	-	-	-	-	-	-	-	-	31
2-Methylphenol	-	-	-	-	-	-	-	-	-
4-Methylphenol	-	-	-	-	-	-	-	-	-
Acenaphthene	-	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	-	-	-	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	-	-	72
Phenanthrene	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-	-	-
Total Petroleum Hydrocarbon	NA	NA	NA	NA	NA	NA	NA	NA	2000

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-406	WMW-406	WMW-406	WMW-406 *	WMW-406I	WMW-406I	WMW-406I	WMW-406I	WMW-406I*
DATE SAMPLED	3/4/94	9/23/94	7/14/95	5/19/92	5/19/92	3/4/94	9/23/94	7/14/95	3/4/94
Volatile Organic Compounds (8020) - µg/l									
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA	NA	NA	NA
Unknown	NA	NA	NA	NA	NA	NA	NA	NA	NA
Unknown Hydrocarbon	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (8240) - µg/l									
1,1-Dichloroethane	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	-	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-	-
2-Hexanone	-	-	-	-	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	-	-	-	-	-	-
Acetone	-	-	-	-	-	-	-	-	-
Benzene	-	-	-	-	-	-	-	-	-
Carbon Disulfide	-	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-	-
Ethylbenzene	84	110	55	470	1100	810	840	760	850
Methylene chloride	-	-	-	-	-	-	-	-	-
Tetrachloroethene	-	-	-	-	-	-	-	-	-
Toluene	25	-	-	-	-	-	82	-	-
Total Xylenes	400	490	290	2600	5400	4000	4000	3500	4100
Trichloroethene	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	98	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	2450	-	-	-	-	3900	-	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-406	WMW-406	WMW-406	WMW-406 *	WMW-406I	WMW-406I	WMW-406I	WMW-406I	WMW-406I*
DATE SAMPLED	3/4/94	9/23/94	7/14/95	5/19/92	5/19/92	3/4/94	9/23/94	7/14/95	3/4/94
Semivolatile Organic Compounds (8270) - µg/l									
2,4-Dichlorophenol	-	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	-	-	-	-	-	-	-	-
2-Methylnaphthalene	42	-	-	30	27	24	-	67	30
2-Methylphenol	-	-	-	-	-	-	-	-	-
4-Methylphenol	-	-	3 J	-	-	-	-	1 J	-
Acenaphthene	-	-	-	-	-	-	-	1 J	-
Anthracene	-	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	2 J	-	-	39	-	5 J	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	1 J	-
Diethylphthalate	-	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	1 J	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-	-
Naphthalene	40	-	-	72	68	43	-	100	54
Phenanthrene	-	-	-	-	-	-	-	1 J	-
Phenol	-	-	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-	-	-
Total Petroleum Hydrocarbon	NA	NA	NA	2000	NA	NA	NA	NA	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-407I 5/19/92	WMW-407I 9/23/94	WMW-407I 7/14/95	WMW-408I 4/14/92	WMW-408I 3/4/94	WMW-409I 3/4/94	WMW-409I 9/22/94	WMW-409I 7/14/95	WMW-410 3/4/94
Volatile Organic Compounds (8020) - µg/l									
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA	NA	NA	NA
Unknown	NA	NA	NA	NA	NA	NA	NA	NA	NA
Unknown Hydrocarbon	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (8240) - µg/l									
1,1-Dichloroethane	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	-	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-	-
2-Hexanone	-	-	-	-	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	-	-	-	-	-	-
Acetone	11	-	-	-	-	30	-	-	-
Benzene	-	-	-	-	-	-	-	-	-
Carbon Disulfide	-	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	6	-	-	-
Ethylbenzene	-	3 J	1 J	-	-	21	22	9	-
Methylene chloride	7	-	-	8	-	-	-	-	-
Tetrachloroethene	-	-	-	-	-	-	-	-	-
Toluene	-	3 J	-	-	-	-	-	-	-
Total Xylenes	-	-	-	-	-	130	150	58	-
Trichloroethene	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	6	-	-	-	-	50	-	-
Unknown Hydrocarbon	-	45	-	-	-	-	950	-	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-407I	WMW-407I	WMW-407I	WMW-408I	WMW-408I	WMW-409I	WMW-409I	WMW-409I	WMW-410
DATE SAMPLED	5/19/92	9/23/94	7/14/95	4/14/92	3/4/94	3/4/94	9/22/94	7/14/95	3/4/94
Semivolatile Organic Compounds (8270) - µg/l									
2,4-Dichlorophenol	-	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	-	-	-	-	-	-	-	-
2-Methylnaphthalene	-	-	-	-	25	-	-	6 J	40
2-Methylphenol	-	-	-	-	-	-	-	-	-
4-Methylphenol	-	-	-	-	-	-	-	-	-
Acenaphthene	-	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	-	-	4 J	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	-	3 J	27
Phenanthrene	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-	-	-
Total Petroleum Hydrocarbon	7000	NA	NA	-	NA	NA	NA	NA	2000

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-410 7/14/95	WMW-410D 3/4/94	WMW-410D 9/22/94	WL24 12/5/89
Volatile Organic Compounds (8020) - µg/l				
1,4-Dichlorobenzene	NA	NA	NA	-
Ethylbenzene	NA	NA	NA	-
Toluene	NA	NA	NA	0.5 J
Total Xylenes	NA	NA	NA	-
Unknown	NA	NA	NA	-
Unknown Hydrocarbon	NA	NA	NA	-
Volatile Organic Compounds (8240) - µg/l				
1,1-Dichloroethane	-	-	-	NA
1,2-Dichloroethane	-	-	-	NA
1,4-Dichlorobenzene	-	-	-	NA
2-Butanone	-	-	-	NA
2-Hexanone	-	-	-	NA
4-Methyl-2-Pentanone	-	-	-	NA
Acetone	-	-	-	NA
Benzene	72	18	-	NA
Carbon Disulfide	-	-	-	NA
Chloroform	-	-	-	NA
Ethylbenzene	420	120	42	NA
Methylene chloride	-	-	-	NA
Tetrachloroethene	-	-	-	NA
Toluene	490	58	-	NA
Total Xylenes	2000	370	120	NA
Trichloroethene	-	-	-	NA
Unknown	-	-	24	NA
Unknown Cyclic Hydrocarbon	-	-	26	NA
Unknown Hydrocarbon	-	-	630	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-410 7/14/95	WMW-410D 3/4/94	WMW-410D 9/22/94	WL24 12/5/89
Semivolatile Organic Compounds (8270) - µg/l				
2,4-Dichlorophenol	-	-	-	-
2,4-Dimethylphenol	4 J	-	-	-
2-Methylnaphthalene	82	-	-	-
2-Methylphenol	-	-	-	-
4-Methylphenol	2 J	-	-	-
Acenaphthene	1 J	-	-	-
Anthracene	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-
Benzyl Alcohol	-	-	-	-
bis(2-Ethylhexyl)phthalate	2 J	-	-	-
Di-n-octylphthalate	-	-	-	-
Dibenzofuran	-	-	-	-
Diethylphthalate	-	-	-	-
Dimethylphthalate	-	-	-	-
Fluoranthene	-	-	-	-
Hexachloroethane	-	-	-	-
Fluorene	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-
Naphthalene	61	-	-	-
Phenanthrene	1 J	-	-	-
Phenol	-	-	-	-
Pyrene	-	-	-	-
Unknown	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-
Unknown Hydrocarbon	-	-	-	-
Total Petroleum Hydrocarbon	NA	1000	NA	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION / DATE SAMPLED	WMW-501 2/7/89	WMW-501 5/19/92	WMW-501 3/7/94	WMW-501 9/22/94	WMW-501 7/14/95	WMW-502 12/7/89	WMW-502 5/19/92	WMW-502 5/20/92
Volatile Organic Compounds (8020) - µg/l								
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA	NA	NA
Unknown	NA	NA	NA	NA	NA	NA	NA	NA
Unknown Hydrocarbon	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (8240) - µg/l								
1,1-Dichloroethane	-	-	-	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-
2-Hexanone	-	-	-	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	-	-	-	-	-
Acetone	460 JB	-	-	3 J	-	-	-	-
Benzene	-	-	-	-	2 J	60	60	-
Carbon Disulfide	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-
Ethylbenzene	920	260	790	310	150	10 J	360	-
Methylene chloride	-	120	-	-	-	-	-	-
Tetrachloroethene	-	-	-	-	-	-	-	-
Toluene	6300	540	1600	490	160	170	-	-
Total Xylenes	4600	1000	3800	1300	360	1190	2000	-
Trichloroethene	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	120	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	100	-	-
Unknown Hydrocarbon	-	-	-	2090	-	290	-	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-501	WMW-501	WMW-501	WMW-501	WMW-501	WMW-502	WMW-502	WMW-502
DATE SAMPLED	2/7/89	5/19/92	3/7/94	9/22/94	7/14/95	12/7/89	5/19/92	5/20/92
Semivolatile Organic Compounds (8270) - µg/l								
2,4-Dichlorophenol	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	61	-	-	-	-	-	-	-
2-Methylnaphthalene	-	-	18	-	-	-	-	-
2-Methylphenol	94	-	-	-	-	-	-	-
4-Methylphenol	13	-	-	-	22	-	-	-
Acenaphthene	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-
Benzyl Alcohol	75	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	25	-	-	-	-	-	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-
Naphthalene	-	16	55	-	-	-	-	44
Phenanthrene	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	1850	-	-	-	-	-	-	-
Unknown Hydrocarbon	100	-	-	-	-	-	-	-
Total Petroleum Hydrocarbons	NA	-	NA	NA	NA	NA	1000	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION / DATE SAMPLED	WMW-502 3/11/94	WMW-502 9/22/94	WMW-502 7/14/95	WMW-502 * 5/19/92	WMW-503 12/7/89	WMW-503 1/28/93	WMW-503 3/11/94	WMW-503 9/23/94
Volatile Organic Compounds (8020) - µg/l								
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA	NA	NA
Unknown	NA	NA	NA	NA	NA	NA	NA	NA
Unknown Hydrocarbon	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (8240) - µg/l								
1,1-Dichloroethane	-	-	-	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-
2-Hexanone	-	-	-	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	-	-	-	-	-
Acetone	-	-	-	-	460 J	-	-	-
Benzene	-	980	51	-	1800	630	750	180
Carbon Disulfide	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-
Ethylbenzene	310	630	370	360	1000	830	1300	790
Methylene chloride	-	-	-	-	690 B	-	-	-
Tetrachloroethene	-	-	-	-	-	-	-	-
Toluene	-	-	-	-	13000	7500	11000	3500
Total Xylenes	1300	2800	1500	2000	6500	4330	5800	4600
Trichloroethene	-	-	-	-	-	-	-	-
Unknown	-	360	-	-	-	-	-	320
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	1700	-	-	-	-	-	1900

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-502 3/11/94	WMW-502 9/22/94	WMW-502 7/14/95	WMW-502 * 5/19/92	WMW-503 12/7/89	WMW-503 1/28/93	WMW-503 3/11/94	WMW-503 9/23/94
Semivolatile Organic								
Compounds (8270) - µg/l								
2,4-Dichlorophenol	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	-	9 J	-	-	-	-	-
2-Methylnaphthalene	14	-	22	-	-	-	52	-
2-Methylphenol	-	-	-	-	-	-	-	-
4-Methylphenol	-	-	2 J	-	-	-	-	-
Acenaphthene	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	2 J	-	-	-	-	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-
Naphthalene	30	-	49	-	-	-	128	-
Phenanthrene	-	-	-	-	-	-	-	-
Phenol	-	-	5 J	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-	-
Total Petroleum Hydrocarbons	NA	NA	NA	2000	NA	NA	NA	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-503	WMW-504	WMW-504	WMW-504	WMW-504	WMW-504	WMW-504 *	WMW-505
DATE SAMPLED	7/14/95	12/5/89	5/18/92	3/7/94	9/22/94	7/14/95	3/7/94	12/5/89
Volatile Organic Compounds (8020) - µg/l								
1,4-Dichlorobenzene	NA	-	NA	NA	NA	NA	NA	-
Ethylbenzene	NA	-	NA	NA	NA	NA	NA	-
Toluene	NA	1700	NA	NA	NA	NA	NA	-
Total Xylenes	NA	4100	NA	NA	NA	NA	NA	-
Unknown	NA	-	NA	NA	NA	NA	NA	-
Unknown Hydrocarbon	NA	-	NA	NA	NA	NA	NA	-
Volatile Organic Compounds (8240) - µg/l								
1,1-Dichloroethane	-	NA	-	-	-	-	-	NA
1,2-Dichloroethane	-	NA	-	-	-	-	-	NA
1,4-Dichlorobenzene	-	NA	-	-	-	-	-	NA
2-Butanone	-	NA	-	-	-	-	-	NA
2-Hexanone	-	NA	-	-	-	-	-	NA
4-Methyl-2-Pentanone	-	NA	-	-	-	-	-	NA
Acetone	-	NA	-	-	-	-	-	NA
Benzene	630	NA	-	-	-	-	-	NA
Carbon Disulfide	-	NA	-	-	-	-	-	NA
Chloroform	-	NA	-	-	-	-	-	NA
Ethylbenzene	1300	NA	850	1800	1200	930	1600	NA
Methylene chloride	-	NA	-	-	-	-	-	NA
Tetrachloroethene	-	NA	-	-	-	-	-	NA
Toluene	13000	NA	740	2000	340 J	-	860	NA
Total Xylenes	6700	NA	4500	9100	5200	5400	7900	NA
Trichloroethene	-	NA	-	-	-	-	-	NA
Unknown	-	NA	-	-	590	-	-	NA
Unknown Cyclic Hydrocarbon	-	NA	-	-	-	-	-	NA
Unknown Hydrocarbon	-	NA	-	-	1910	-	-	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-503 7/14/95	WMW-504 12/5/89	WMW-504 5/18/92	WMW-504 3/7/94	WMW-504 9/22/94	WMW-504 7/14/95	WMW-504 * 3/7/94	WMW-505 12/5/89
Semivolatile Organic Compounds (8270) - µg/l								
2,4-Dichlorophenol	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	17 J	-	-	27	-	51	-	-
2-Methylnaphthalene	40	-	73	-	-	61	74	-
2-Methylphenol	55	-	-	-	-	7 J	-	-
4-Methylphenol	68	-	-	-	-	11	-	-
Acenaphthene	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	10 J	-	-	-	-	3 J	-	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-
Naphthalene	120	-	120	145	-	110	150	-
Phenanthrene	-	-	-	-	-	-	-	-
Phenol	10 J	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-	-
Total Petroleum Hydrocarbons	NA	NA	16000	NA	NA	NA	NA	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-505	WMW-505	WMW-506	WMW-506	WMW-506	WMW-506	WMW-506I	WMW-506I
DATE SAMPLED	1/28/94	7/13/95	12/5/89	1/28/93	3/11/94	7/13/95	5/18/92	5/19/92
Volatile Organic Compounds (8020) - µg/l								
1,4-Dichlorobenzene	NA	NA	-	NA	NA	NA	-	NA
Ethylbenzene	NA	NA	1.1	NA	NA	NA	480	NA
Toluene	NA	NA	0.5 J	NA	NA	NA	220	NA
Total Xylenes	NA	NA	0.8 J	NA	NA	NA	2100	NA
Unknown	NA	NA	-	NA	NA	NA	-	NA
Unknown Hydrocarbon	NA	NA	-	NA	NA	NA	-	NA
Volatile Organic Compounds (8240) - µg/l								
1,1-Dichloroethane	-	-	NA	-	-	-	NA	-
1,2-Dichloroethane	-	-	NA	-	-	-	NA	-
1,4-Dichlorobenzene	-	-	NA	-	-	-	NA	-
2-Butanone	-	-	NA	-	-	-	NA	-
2-Hexanone	-	-	NA	-	-	-	NA	-
4-Methyl-2-Pentanone	-	-	NA	-	-	-	NA	-
Acetone	-	-	NA	-	-	-	NA	-
Benzene	-	-	NA	-	-	-	NA	-
Carbon Disulfide	-	-	NA	-	-	-	NA	-
Chloroform	-	-	NA	-	-	-	NA	-
Ethylbenzene	-	-	NA	-	12	-	NA	-
Methylene chloride	8.2 B	-	NA	7.9 B	-	-	NA	-
Tetrachloroethene	-	-	NA	-	-	-	NA	-
Toluene	-	-	NA	-	-	-	NA	-
Total Xylenes	-	-	NA	-	32	-	NA	-
Trichloroethene	-	-	NA	-	-	-	NA	-
Unknown	-	-	NA	-	-	-	NA	-
Unknown Cyclic Hydrocarbon	-	-	NA	-	-	-	NA	-
Unknown Hydrocarbon	-	-	NA	-	-	-	NA	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-505	WMW-505	WMW-506	WMW-506	WMW-506	WMW-506	WMW-506I	WMW-506I
DATE SAMPLED	1/28/94	7/13/95	12/5/89	1/28/93	3/11/94	7/13/95	5/18/92	5/19/92
Semivolatile Organic								
Compounds (8270) - µg/l								
2,4-Dichlorophenol	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	-	-	-	-	2 J	-	-
2-Methylnaphthalene	-	-	-	-	-	-	-	41
2-Methylphenol	-	-	-	-	-	-	-	-
4-Methylphenol	-	-	-	-	-	-	-	-
Acenaphthene	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	2 J	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	-	-	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-
Fluoranthene	-	1 J	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	2 J	-	72
Phenanthrene	-	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-
Pyrene	-	1 J	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-	-
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA	NA	3000	NA

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-506I 3/11/94	WMW-506I 9/22/94	WMW-506I 7/13/95	WMW-507 5/19/92	WMW-507 7/13/95	WMW-507 * 7/13/95	WMW-508 5/19/92	WMW-509D 5/18/92
Volatile Organic Compounds (8020) - µg/l								
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA	NA	NA
Unknown	NA	NA	NA	NA	NA	NA	NA	NA
Unknown Hydrocarbon	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (8240) - µg/l								
1,1-Dichloroethane	-	-	-	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	-	-	-	-	-	-	-	-
2-Butanone	-	-	-	-	-	-	-	-
2-Hexanone	-	-	-	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	-	-	-	-	-
Acetone	-	130 J	140	11	1 J	-	-	-
Benzene	-	-	13 J	-	-	-	-	22
Carbon Disulfide	-	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-	-
Ethylbenzene	1000	1000	610	-	-	-	-	-
Methylene chloride	-	-	-	13	-	-	11	-
Tetrachloroethene	-	-	-	-	-	-	-	-
Toluene	330	310	-	-	-	-	-	-
Total Xylenes	4400	4500	3400	-	-	6 J	-	-
Trichloroethene	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	4500	-	-	-	-	-	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-506I 3/11/94	WMW-506I 9/22/94	WMW-506I 7/13/95	WMW-507 5/19/92	WMW-507 7/13/95	WMW-507 * 7/13/95	WMW-508 5/19/92	WMW-509D 5/18/92
Semivolatile Organic Compounds (8270) - µg/l								
2,4-Dichlorophenol	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	34	-	8 J	-	-	-	-	-
2-Methylnaphthalene	37	-	58	-	-	-	-	-
2-Methylphenol	-	-	-	-	-	-	-	-
4-Methylphenol	-	-	-	-	-	-	-	-
Acenaphthene	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	-	-	-
Di-n-octylphthalate	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-	-
Naphthalene	81	-	100	-	-	-	-	-
Phenanthrene	-	-	2 J	-	-	-	-	-
Phenol	-	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-	-
Total Petroleum Hydrocarbons	NA	NA	NA	-	NA	NA	-	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-510I 3/7/94	WMW-510I 7/13/95	WMW-5D 5/20/92	WMW-5D 1/28/93	WMW-5D 3/11/94	WMW-5D 9/21/94	WMW-5D 7/13/95
Volatile Organic Compounds (8020) - µg/l							
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA	NA
Unknown	NA	NA	NA	NA	NA	NA	NA
Unknown Hydrocarbon	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (8240) - µg/l							
1,1-Dichloroethane	-	-	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	-
1,4-Dichlorobenzene	-	-	-	-	-	34	-
2-Butanone	-	-	-	-	-	-	-
2-Hexanone	-	-	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	-	-	-	-
Acetone	-	-	93	39 J	-	22	-
Benzene	-	5	6	3.6	-	-	1 J
Carbon Disulfide	-	-	-	-	-	-	-
Chloroform	-	-	-	-	-	-	-
Ethylbenzene	11	16	13	97	210	17	-
Methylene chloride	-	-	-	10 B	-	-	-
Tetrachloroethene	-	-	-	-	-	-	-
Toluene	-	-	-	-	-	11	-
Total Xylenes	14	-	-	-	-	-	-
Trichloroethene	-	-	14	31	-	22	3 J
Unknown	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION DATE SAMPLED	WMW-510I 3/7/94	WMW-510I 7/13/95	WMW-5D 5/20/92	WMW-5D 1/28/93	WMW-5D 3/11/94	WMW-5D 9/21/94	WMW-5D 7/13/95
Semivolatile Organic Compounds (8270) - µg/l							
2,4-Dichlorophenol	-	-	-	-	-	-	-
2,4-Dimethylphenol	-	-	-	-	-	-	-
2-Methylnaphthalene	-	-	18	-	34	-	13
2-Methylphenol	-	-	-	-	-	-	-
4-Methylphenol	-	-	-	-	-	-	-
Acenaphthene	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	-	-	-	-	-	-	2 J
Di-n-octylphthalate	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-
Dimethylphthalate	-	-	-	-	-	-	-
Fluoranthene	-	-	-	-	-	-	-
Hexachloroethane	-	-	-	-	-	-	-
Fluorene	-	-	-	-	-	-	-
n-Nitrosodiphenylamine	-	-	-	-	-	-	-
Naphthalene	-	-	62	-	73	-	43
Phenanthrene	-	-	-	-	-	-	-
Phenol	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-
Unknown Cyclic Hydrocarbon	-	-	-	-	-	-	-
Unknown Hydrocarbon	-	-	-	-	-	-	-
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA	NA	NA

SUMMARY OF ANALYTES DETECTED IN SOIL
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-401	WMW-401	WMW-402	WMW-402	WMW-403	WMW-403	WSB-401	WSB-401	WSB-402
DATE SAMPLED	32518	32518	32518	32518	32518	32518	32504	32504	32504
DEPTH	10-12	20-22	10-12	20-22	10-12	20-22	10-12	20-22	10-12
Volatile Organic Compounds (8240) - µg/kg									
1,1,1-Trichloroethane	3 J	2 J	-	-	-	-	-	-	-
Acetone	19	34	-	-	18	47	-	-	28
Ethylbenzene	-	-	-	23000 J	-	-	-	-	-
Methylene Chloride	10 B	12 B	7 B	250000 B	-	15 B	8	-	8
Toluene	-	-	-	8400 J	-	-	-	-	-
Xylenes (total)	-	-	-	150000	-	-	-	1900 J	-
Semivolatile Organic Compounds (8270) - µg/kg									
2-Methylnaphthalene	NA	NA	NA	2800	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	170 JB	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	2000	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	-	NA	NA	NA	NA	NA
Total Inorganics - mg/kg									
Arsenic	NA	-	NA	NA	NA	NA	NA	NA	NA
Barium	NA	22.1	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	0.47	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	5.09	NA	NA	NA	NA	NA	NA	NA
Lead	NA	-	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	0.19	NA	NA	NA	NA	NA	NA	NA
Total TICs - mg/kg	-	-	-	330.9	-	-	-	250	-

SUMMARY OF ANALYTES DETECTED IN SOIL
PUMPHOUSE NO. 6

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WSB-402	WSB-403	WSB-403	WSB-404	WSB-404	WSB-405	WSB-405
DATE SAMPLED	32504	32504	32504	32504	32504	32528	32528
DEPTH	20-22	10-12	20-22	10-12	20-22	10-12	20-22
Volatile Organic Compounds (8240) - µg/kg							
1,1,1-Trichloroethane	-	-	-	-	-	-	-
Acetone	51000 J	20 B	36 B	13 B	-	26	36
Ethylbenzene	120000	-	-	-	-	-	-
Methylene Chloride	-	6	6	3 J	-	8 B	13 B
Toluene	100000	-	-	-	-	-	-
Xylenes (total)	630000	-	-	-	-	-	-
Semivolatile Organic Compounds (8270) - µg/kg							
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA
Total Inorganics - mg/kg							
Arsenic	NA	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA	NA
Total TICs - mg/kg	4400	-	-	-	241	-	NA

SUMMARY OF ANALYTES DETECTED IN SOIL
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-301	WMW-301	WMW-302	WMW-302	WMW-303	WMW-303	WMW-303	WSB-301	WSB-301
DATE SAMPLED	12/29/88	12/29/88	12/29/88	12/29/88	12/30/88	12/30/88	12/30/88	12/20/88	12/20/88
DEPTH	10-12	20-22	10-12	20-22	10-12	15-17	20-22	10-12	20-22
Volatile Organic Compounds (8240) - µg/kg									
1,1,1-Trichloroethane	16	31	16	32	-	NA	-	-	-
2-Butanone (MEK)	-	14	8 J	11	-	NA	-	-	-
Acetone	48 B	140 B	92 B	120 B	7 J	NA	-	-	19 B
Ethylbenzene	-	-	-	-	-	NA	-	-	-
Methylene Chloride	35 B	62 B	32 B	54 B	-	NA	-	40	8
Tetrachloroethene	-	-	-	4 J	-	NA	-	-	-
Toluene	-	-	-	-	-	NA	-	1 J	1 J
Xylenes (total)	-	-	-	-	-	NA	-	-	-
Semivolatile Organic Compounds (8270) - µg/kg									
2-Methylnaphthalene	NA	NA	NA	NA	NA	-	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	83 JB	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	-	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	-	NA	NA	NA
Total Inorganics - mg/kg									
Arsenic	NA	NA	NA	NA	NA	-	NA	NA	NA
Barium	NA	NA	NA	NA	NA	19.4	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	0.5	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	5.72	NA	NA	NA
Lead	NA	NA	NA	NA	NA	1.42	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	-	NA	NA	NA
Total TICs - mg/kg	-	-	-	-	-	1	270	-	-

SUMMARY OF ANALYTES DETECTED IN SOIL
PUMPHOUSE NO. 3

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WSB-302	WSB-302	WSB-303	WSB-303
DATE SAMPLED	12/21/88	12/21/88	12/21/88	12/21/88
DEPTH	10-12	20-22	10-12	20-22
Volatile Organic Compounds (8240) - µg/kg				
1,1,1-Trichloroethane	-	-	-	-
2-Butanone (MEK)	-	-	-	-
Acetone	36 B	1200	8 J	-
Ethylbenzene	-	20000	-	1000
Methylene Chloride	5 B	-	10	-
Tetrachloroethene	-	-	-	-
Toluene	-	8200	-	-
Xylenes (total)	-	NA	-	3400
Semivolatile Organic Compounds (8270) - µg/kg				
2-Methylnaphthalene	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA
Total Inorganics - mg/kg				
Arsenic	NA	NA	NA	NA
Barium	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA
Chromium	NA	NA	NA	NA
Lead	NA	NA	NA	NA
Mercury	NA	NA	NA	NA
Total TICs - mg/kg	0.168	880	-	1700

SUMMARY OF ANALYTES DETECTED IN SOIL
PUMPHOUSE NO. 1

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-101	WMW-101	WMW-102	WMW-102	WMW-102	WSB-101	WSB-101	WSB-102	WSB-102
DATE SAMPLED	12/28/88	12/28/88	12/28/88	12/28/88	12/28/88	12/19/88	12/19/88	12/20/88	12/20/88
DEPTH	10-12	20-22	10-12	20-22	25-27	10-12	20-22	10-12	20-22
Volatile Organic Compounds (8240) - µg/kg									
1,1,1-Trichloroethane	18	-	11	10	NA	-	-	-	-
Acetone	15 B	39	8 JB	21 B	NA	56 B	-	17 B	42 B
Methylene Chloride	12 B	4 J	11 B	13 B	NA	6	22 JB	2 J	2 J
Tetrachloroethene	3 J	-	-	-	NA	-	-	-	-
Toluene	2 J	-	-	-	NA	1 J	-	1 J	1 J
Semivolatile Organic Compounds (8270) - µg/kg									
2-Methylnaphthalene	NA	NA	NA	NA	-	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	75 JB	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	-	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	-	NA	NA	NA	NA
Total Inorganics - mg/kg									
Arsenic	NA	NA	NA	NA	-	NA	NA	NA	NA
Barium	NA	NA	NA	NA	21.9	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	-	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	5.97	NA	NA	NA	NA
Lead	NA	NA	NA	NA	-	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	0.12	NA	NA	NA	NA
Total TICs - mg/kg	-	-	-	-	2.7	-	-	-	-

SUMMARY OF ANALYTES DETECTED IN SOIL
PUMPHOUSE NO. 1

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WSB-103	WSB-103
DATE SAMPLED	12/20/88	12/20/88
DEPTH	10-12	20-22
Volatile Organic Compounds (8240) - µg/kg		
1,1,1-Trichloroethane	-	-
Acetone	-	-
Methylene Chloride	3 J	4 J
Tetrachloroethene	-	-
Toluene	-	1 J
Semivolatile Organic Compounds (8270) - µg/kg		
2-Methylnaphthalene	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA
Naphthalene	NA	NA
Phenanthrene	NA	NA
Total Inorganics - mg/kg		
Arsenic	NA	NA
Barium	NA	NA
Cadmium	NA	NA
Chromium	NA	NA
Lead	NA	NA
Mercury	NA	NA
Total TICs - mg/kg	-	-

SUMMARY OF ANALYTES DETECTED IN SOIL
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WMW-501	WMW-501	WMW-502	WMW-502	WMW-503	WMW-503	WMW-503	WSB-501
DATE SAMPLED	32511	32511	32511	32511	32511	32512	32511	32498
DEPTH	10-12	20-22	10-12	20-22	10-12	15-17	20-22	10-12
Volatile Organic Compounds (8240) - µg/kg								
4-Methyl-2-pentanone	-	-	-	-	-	NA	-	-
Acetone	38	-	-	28	9	NA	19	7
Benzene	-	-	-	-	-	NA	-	-
Ethylbenzene	-	360 J	-	2 J	-	NA	-	-
Methylene Chloride	96 B	2300 B	60 B	68 B	26	NA	29 B	-
Toluene	1 J	770	-	3	-	NA	3	-
Xylenes (total)	-	2200	-	-	-	NA	-	-
Semivolatile Organic Compounds (8270) - µg/kg								
2-Methylnaphthalene	NA	NA	NA	NA	NA	-	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	76 JB	NA	NA
Naphthalene	NA	NA	NA	NA	NA	-	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	-	NA	NA
Total Inorganics - mg/kg								
Arsenic	NA	NA	NA	NA	NA	1.84	NA	NA
Barium	NA	NA	NA	NA	NA	22.8	NA	NA
Cadmium	NA	NA	NA	NA	NA	0.57	NA	NA
Chromium	NA	NA	NA	NA	NA	6.12	NA	NA
Lead	NA	NA	NA	NA	NA	-	NA	NA
Mercury	NA	NA	NA	NA	NA	-	NA	NA
Total TICs - mg/kg	-	11	-	-	-	0.7	-	0.023

SUMMARY OF ANALYTES DETECTED IN SOIL
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WSB-501	WSB-502	WSB-502	WSB-503	WSB-503	WSB-510	WSB-510	WSB-510
DATE SAMPLED	32498	32498	32498	32498	32498	34393	34393	34393
DEPTH	20-22	10-12	20-22	10-12	20-22	1.5-3	15-17	20-22
Volatile Organic Compounds (8240) - µg/kg								
4-Methyl-2-pentanone	3300	-	-	-	-	-	-	-
Acetone	880	14	-	-	23	65	-	-
Benzene	-	-	-	-	-	-	-	32
Ethylbenzene	2300	-	9200	-	-	-	-	48
Methylene Chloride	370 J	4 J	-	7	8	-	-	-
Toluene	1200	6	4900	11	-	-	-	380
Xylenes (total)	13000	-	30000	-	9	62	8700	270
Semivolatile Organic Compounds (8270) - µg/kg								
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA
Total Inorganics - mg/kg								
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA	NA	NA
Total TICs - mg/kg	410	-	124	-	0.037	-	-	-

SUMMARY OF ANALYTES DETECTED IN SOIL
DEFUELING AREA NO. 2

FORMER WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

LOCATION	WSB-511	WSB-513	WSB-513
DATE SAMPLED	34393	34393	34393
DEPTH	20-22	10-12	20-22
Volatile Organic Compounds (8240) - µg/kg			
4-Methyl-2-pentanone	-	-	-
Acetone	-	-	21
Benzene	-	-	-
Ethylbenzene	-	-	18
Methylene Chloride	-	-	-
Toluene	7	-	140
Xylenes (total)	-	-	130
Semivolatile Organic Compounds (8270) - µg/kg			
2-Methylnaphthalene	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA
Naphthalene	NA	NA	NA
Phenanthrene	NA	NA	NA
Total Inorganics - mg/kg			
Arsenic	NA	NA	NA
Barium	NA	NA	NA
Cadmium	NA	NA	NA
Chromium	NA	NA	NA
Lead	NA	NA	NA
Mercury	NA	NA	NA
Total TICs - mg/kg	-	-	-

O'REILLY, TALBOT, AND OKUN SITE ASSESSMENT DATA FOR PROPERTY TRANSFER TO U.S. TSUBAKI, INC.

SPECTRUM ANALYTICAL, INC.

Laboratory Report

Client ID: **SB-8/S-7**
Lab ID No: **AA51996**

Location: **Chicopee**
Client Job No.: **182-0103**

Matrix: Soil
Sampled on04/30/96 by O'R&T&O
Received on 05/01/96 by MD
QC and Data Review by DDR

Preservative: Refrigeration
Container : 1 Glass Soil Jar
Condition of Sample as Received: Satisfactory
Delivered by: Client

Volatile Organics

EPA Methods 624 / 8240

Parameter	Result (in ug/Kg)	MDL	Extracted	Analyzed	Analyst
Benzene	Not detected	50	05/02/96	05/02/96	GM
Bromodichloromethane	Not detected	50	05/02/96	05/02/96	GM
Bromoform	Not detected	50	05/02/96	05/02/96	GM
Carbon tetrachloride	Not detected	50	05/02/96	05/02/96	GM
Chlorobenzene	Not detected	50	05/02/96	05/02/96	GM
Chloroform	Not detected	50	05/02/96	05/02/96	GM
Dibromochloromethane	Not detected	50	05/02/96	05/02/96	GM
1,2-Dichlorobenzene	Not detected	50	05/02/96	05/02/96	GM
1,3-Dichlorobenzene	Not detected	50	05/02/96	05/02/96	GM
1,4-Dichlorobenzene	Not detected	50	05/02/96	05/02/96	GM
1,1-Dichloroethane	Not detected	50	05/02/96	05/02/96	GM
1,2-Dichloroethane	Not detected	50	05/02/96	05/02/96	GM
1,1-Dichloroethene	Not detected	50	05/02/96	05/02/96	GM
trans-1,2-Dichloroethene	Not detected	50	05/02/96	05/02/96	GM
1,2-Dichloropropane	Not detected	50	05/02/96	05/02/96	GM
cis-1,3-Dichloropropene	Not detected	50	05/02/96	05/02/96	GM
trans-1,3-Dichloropropene	Not detected	50	05/02/96	05/02/96	GM
Ethylbenzene	Not detected	50	05/02/96	05/02/96	GM
Methylene chloride	Not detected	125	05/02/96	05/02/96	GM
1,1,2,2-Tetrachloroethane	Not detected	50	05/02/96	05/02/96	GM
Tetrachloroethene	Not detected	50	05/02/96	05/02/96	GM
Toluene	Not detected	50	05/02/96	05/02/96	GM
1,1,1-Trichloroethane	Not detected	50	05/02/96	05/02/96	GM
1,1,2-Trichloroethane	Not detected	50	05/02/96	05/02/96	GM
Trichloroethene	Not detected	50	05/02/96	05/02/96	GM
Trichlorofluoromethane	Not detected	50	05/02/96	05/02/96	GM
m,p-Xylenes	80	100	05/02/96	05/02/96	GM
o-Xylene	50	50	05/02/96	05/02/96	GM
Methyl-t-butyl ether	Not detected	50	05/02/96	05/02/96	GM
BFB Surrogate Recovery (%)	91		05/02/96	05/02/96	GM
p-DFB Surrogate Recovery (%)	107		05/02/96	05/02/96	GM
CLB-d5 Surrogate Recovery (%)	104		05/02/96	05/02/96	GM
% Solids	81.5	0.1	05/02/96	05/02/96	JM

SPECTRUM ANALYTICAL, INC.

Laboratory Report

Client ID: **SB-8/S-7**
Lab ID No: **AA51996**

Location: **Chicopee**
Client Job No.: **182-0103**

Matrix: Soil
Collected: 04/30/96 by O'R&T&O
Received on 05/01/96 by MD
QC and Data Review by DDR

Preservative: Refrigeration
Container : 1 Glass Soil Jar
Condition of Sample as Received: Satisfactory
Delivered by: Client

Total Petroleum Hydrocarbons by GC

Modified EPA Method 8100

Parameter	Result (mg/Kg)	MDL	Extracted	Analyzed	Analyst
Total Hydrocarbons (GC)	Not detected		05/02/96	05/03/96	ATP
Fingerprint based quantification:					
Gasoline	Not detected	40	05/02/96	05/03/96	ATP
Fuel Oil #2	Not detected	40	05/02/96	05/03/96	ATP
Fuel Oil #4	Not detected	40	05/02/96	05/03/96	ATP
Fuel Oil #6	Not detected	80	05/02/96	05/03/96	ATP
Motor Oil	Not detected	80	05/02/96	05/03/96	ATP
Ligroin	Not detected	40	05/02/96	05/03/96	ATP
Aviation Fuel	Not detected	40	05/02/96	05/03/96	ATP
Other Oil	Not detected	80	05/02/96	05/03/96	ATP
Unidentified	Not detected		05/02/96	05/03/96	ATP
% Solids	81.5	0.1	05/02/96	05/02/96	JM

Petroleum identification is determined by comparing the GC fingerprint obtained from the sample with a library of GC fingerprints obtained from petroleum products. Possible match categories are as follows;

Gasoline - includes regular, unleaded, premium, etc.
Fuel Oil #2 - includes home heating oil, #2 fuel oil and diesel.
Fuel Oil #4 - Includes #4 Fuel Oil
Fuel Oil #6 - includes #6 oil and bunker "C" oil.
Motor Oil - includes virgin and waste automobile oils.
Ligroin - includes mineral spirits, petroleum naphtha, vm&p naphtha.
Aviation Fuels - includes Kerosene, Jet A and JP-4.
Other Oil - includes cutting and lubricating oils.

Factors such as microbial degradation, weathering and solubility generally prevent specific identification within a petroleum category. A finding of "unidentified" means that the sample fingerprint was characteristic of a petroleum product, but could not be matched to a fingerprint in the library.

After fingerprint identification, the amount present in the sample is quantified using a calibration curve prepared from a petroleum product of the same category as the identified petroleum. Unidentified petroleum is quantified using a petroleum calibration that approximates the distribution of compounds in the sample. A * in the results column indicates the petroleum calibration used to quantify unidentified samples.

Spectrum Analytical, Inc.
Laboratory Report Supplement

References

Methods for the Determination of Organic Compounds in Drinking Water. EPA-600/4-88/039. EMSL 1988.

Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79-020. EMSL 1983.

Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater. EPA 600/4-82-057. EMSL 1982.

Test Methods for Evaluating Solid Waste. Physical/Chemical Methods. EPA SW-846. 1986.

Standard Methods for the Examination of Water and Wastes. APHA-AWWA-WPCF. 16th Edition. 1985.

Standard Methods for Comparison of Waterborne Petroleum Oils by Gas Chromatography. ASTM D 3328. 1982.

Oil Spill Identification System. U.S. Coast Guard CG-D-52-77. 1977.

Handbook for Analytical Quality Control in Water and Wastewater Laboratories. EPA 600/4-79-019. EMSL 1979.

Choosing Cost-Effective QA/QC (Quality Assurance/Quality Control) Programs for Chemical Analyses. EPA 600/4-85/056. EMSL 1985.

Report Notations

Not Detected, Not Det, ND or nd	=	*The compound was not detected at a concentration equal to or above the established method detection limit.*
NC	=	*Not Calculated*
VOA	=	*Volatile Organic Analysis*
BFB	=	*4-Bromofluorobenzene (an EPA 624 Surrogate)*
p-DFB	=	*1,4-Difluorobenzene (an EPA 624 Surrogate)*
CLB-d5	=	*Chlorobenzene-d5 (an EPA 624 Surrogate)*
BCP	=	*2-Bromo-1-chloropropane (an EPA 601 Surrogate)*
TFT	=	*a,a,a-Trifluorotoluene (an EPA 602 Surrogate)*
Decachlorobiphenyl	=	*(An EPA 608/8080 Surrogate)*

Definitions

Surrogate Recovery = The recovery (expressed as a percent) of a non method analyte (see surrogates listed above) added to the sample for the purpose of monitoring system performance.

Matrix Spike Recovery = The recovery (expressed as a percent) of method analytes added to the sample for the purpose of determining any effect of sample composition on analyte recovery.

Laboratory Replicate = Two sample aliquots taken in the analytical laboratory and analyzed separately with identical procedures. Analyses of laboratory duplicates give a measure of the precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Field Duplicate = Two separate samples collected at the same time and place under identical circumstances and treated exactly the same throughout field and laboratory procedures. Analysis of Field duplicates give a measure of the precision associated with sample collection, preservation and storage, as well as with laboratory procedures.

Relative Percent Difference (% RPD) = The precision measurement obtained on duplicate/replicate analyses. %RPD is calculated as:

$$\%RPD = \frac{|value1 - value2|}{ave.\ value} * 100\%$$

SPECTRUM ANALYTICAL, INC.

Laboratory Report

Client ID: **SB-8**
Lab ID No: **AA52386**

Location: **Chicopee, MA**
Client Job No.: **J1820103**

Matrix: **Water**
Sampled on05/07/96 by O'R&T&O
Received on 05/08/96 by MD
QC and Data Review by

Preservative: Refrigeration, HCl
Container : 2 VOA Vials
Condition of Sample as Received: Satisfactory
Delivered by: Client

Volatile Organics

EPA Methods 624 / 8240

Parameter	Result (in ug/L)	MDL	Analyzed	Analyst
Benzene	Not detected	10	05/09/96	SC
Bromodichloromethane	Not detected	10	05/09/96	SC
Bromomethane	Not detected	10	05/09/96	SC
Bromoform	Not detected	10	05/09/96	SC
Carbon tetrachloride	Not detected	10	05/09/96	SC
Chlorobenzene	Not detected	10	05/09/96	SC
Chloroethane	Not detected	50	05/09/96	SC
Chloroform	Not detected	10	05/09/96	SC
Chloromethane	Not detected	50	05/09/96	SC
Dibromochloromethane	Not detected	10	05/09/96	SC
1,2-Dichlorobenzene	Not detected	10	05/09/96	SC
1,3-Dichlorobenzene	Not detected	10	05/09/96	SC
1,4-Dichlorobenzene	Not detected	10	05/09/96	SC
1,1-Dichloroethane	Not detected	10	05/09/96	SC
1,2-Dichloroethane	Not detected	10	05/09/96	SC
1,1-Dichloroethene	Not detected	10	05/09/96	SC
trans-1,2-Dichloroethene	Not detected	10	05/09/96	SC
1,2-Dichloropropane	Not detected	10	05/09/96	SC
cis-1,3-Dichloropropene	Not detected	10	05/09/96	SC
trans-1,3-Dichloropropene	Not detected	10	05/09/96	SC
Ethylbenzene	570	10	05/09/96	SC
Methylene chloride	Not detected	25	05/09/96	SC
1,1,2,2-Tetrachloroethane	Not detected	10	05/09/96	SC
Tetrachloroethene	Not detected	10	05/09/96	SC
Toluene	640	10	05/09/96	SC
1,1,1-Trichloroethane	Not detected	10	05/09/96	SC
1,1,2-Trichloroethane	Not detected	10	05/09/96	SC
Trichloroethene	Not detected	10	05/09/96	SC
Trichlorofluoromethane	Not detected	10	05/09/96	SC
m,p-Xylenes	1,400	20	05/09/96	SC
o-Xylene	570	10	05/09/96	SC
Vinyl chloride	Not detected	10	05/09/96	SC
Methyl-t-butyl ether	140	10	05/09/96	SC
BFB Surrogate Recovery (%)	102		05/09/96	SC
p-DFB Surrogate Recovery (%)	97		05/09/96	SC
CLB-d5 Surrogate Recovery (%)	98		05/09/96	SC

SPECTRUM ANALYTICAL, INC.

Laboratory Report

Client ID: **SB-8**
Lab ID No: **AA52386**

Location: **Chicopee, MA**
Client Job No.: **J1820103**

Matrix: Water
Collected: 05/07/96 by O'R&T&O
Received on 05/08/96 by MD
QC and Data Review by HT

Preservative: Refrigeration
Container : 1 Amber Glass Liter
Condition of Sample as Received: Satisfactory
Delivered by: Client

Total Hydrocarbons by GC

Modified EPA Method 8100

Parameter	Result (mg/L)	MDL	Extracted	Analyzed	Analyst
Total Hydrocarbons (GC)	22		05/13/96	05/14/96	ATP
Fingerprint based quantification:					
Gasoline	22	0.2	05/13/96	05/14/96	ATP
Fuel Oil #2	Not detected	0.4	05/13/96	05/14/96	ATP
Fuel Oil #4	Not detected	0.7	05/13/96	05/14/96	ATP
Fuel Oil #6	Not detected	0.7	05/13/96	05/14/96	ATP
Motor Oil	Not detected	0.7	05/13/96	05/14/96	ATP
Ligroin	Not detected	0.4	05/13/96	05/14/96	ATP
Aviation Fuel	*	0.4	05/13/96	05/14/96	ATP
Other Oil	Not detected	0.7	05/13/96	05/14/96	ATP
Unidentified	22		05/13/96	05/14/96	ATP

Petroleum identification is determined by comparing the GC fingerprint obtained from the sample with a library of GC fingerprints obtained from petroleum products. Possible match categories are as follows;

Gasoline - includes regular, unleaded, premium, etc.
Fuel Oil #2 - includes home heating oil, #2 fuel oil and diesel.
Fuel Oil #4 - Includes #4 Fuel Oil.
Fuel Oil #6 - includes #6 oil and bunker "C" oil.
Motor Oil - includes virgin and waste automobile.
Ligroin - includes mineral spirits, petroleum naphtha, vm&p naphtha.
Aviation Fuels - includes Kerosene, Jet A and JP-4.
Other Oil - includes lubricating and cutting oil and silicon oil.

Factors such as microbial degradation, weathering and solubility generally prevent specific identification within a petroleum category. A finding of "unidentified" means that the sample fingerprint was characteristic of a petroleum product, but could not be matched to a fingerprint in the library.

After fingerprint identification, the amount present in the sample is quantified using a calibration curve prepared from a petroleum product of the same category as the identified petroleum. Unidentified petroleum is quantified using a petroleum calibration that approximates the distribution of compounds in the sample. A * in the results column indicates the petroleum calibration used to quantify unidentified samples.

Matrix Analytical, Inc.
106 South Street
Hopkinton, MA 01748-2295
1 (800) 362-8749

FINAL REPORT

Client Information

Account:	O'Reilly, Talbot & Okun Assoc.,Inc.	Project Name:	OTO (5-7-96)
Address:	58A Bond St	Project Number:	J182-01-02
	E. Longmeadow, MA 01128	Project Manager:	B.Nicholson
		Sampler Name:	O'Reilly, Talbot & Okun Assoc. Inc

Sample Information

Lab ID:	61282079-008	Date Sampled:	05/07/96 :
Client ID:	SB-8	Date Received:	05/07/96 : 0
Matrix:	Water	Date Reported:	05/16/96

Analytical Parameter	Result	Unit	Detection Limit	Method No.	Analyst	Date Analyzed
SAMPLE PREPARATION						
Metal Digestion	05/08/96			3015		
Mercury Digestion	05/09/96			7470/7471		
TRACE METALS						
Antimony	ND	mg/l	0.003	204.2	kb	05/10/96
Arsenic	ND	mg/l	0.005	206.3	th	05/14/96
Beryllium	ND	mg/l	0.002	200.7	th	05/15/96
Cadmium	ND	mg/l	0.001	213.2	kb	05/15/96
Chromium	ND	mg/l	0.02	200.7	th	05/15/96
Copper	ND	mg/l	0.04	200.7	th	05/15/96
Lead	0.005	mg/l	0.001	239.2	kb	05/15/96
Mercury	ND	mg/l	0.001	245.1	mm	05/09/96
Nickel	ND	mg/l	0.01	200.7	th	05/15/96
Selenium	ND	mg/l	0.005	270.3	th	05/14/96
Silver	ND	mg/l	0.007	200.7	th	05/10/96
Thallium	ND	mg/l	0.001	279.2	kb	05/10/96
Zinc	ND	mg/l	0.05	200.7	th	05/15/96

TIGHE & BOND FIGURES AND TPH DATA FOR WESTOVER INTERCEPTOR SEWER PROJECT

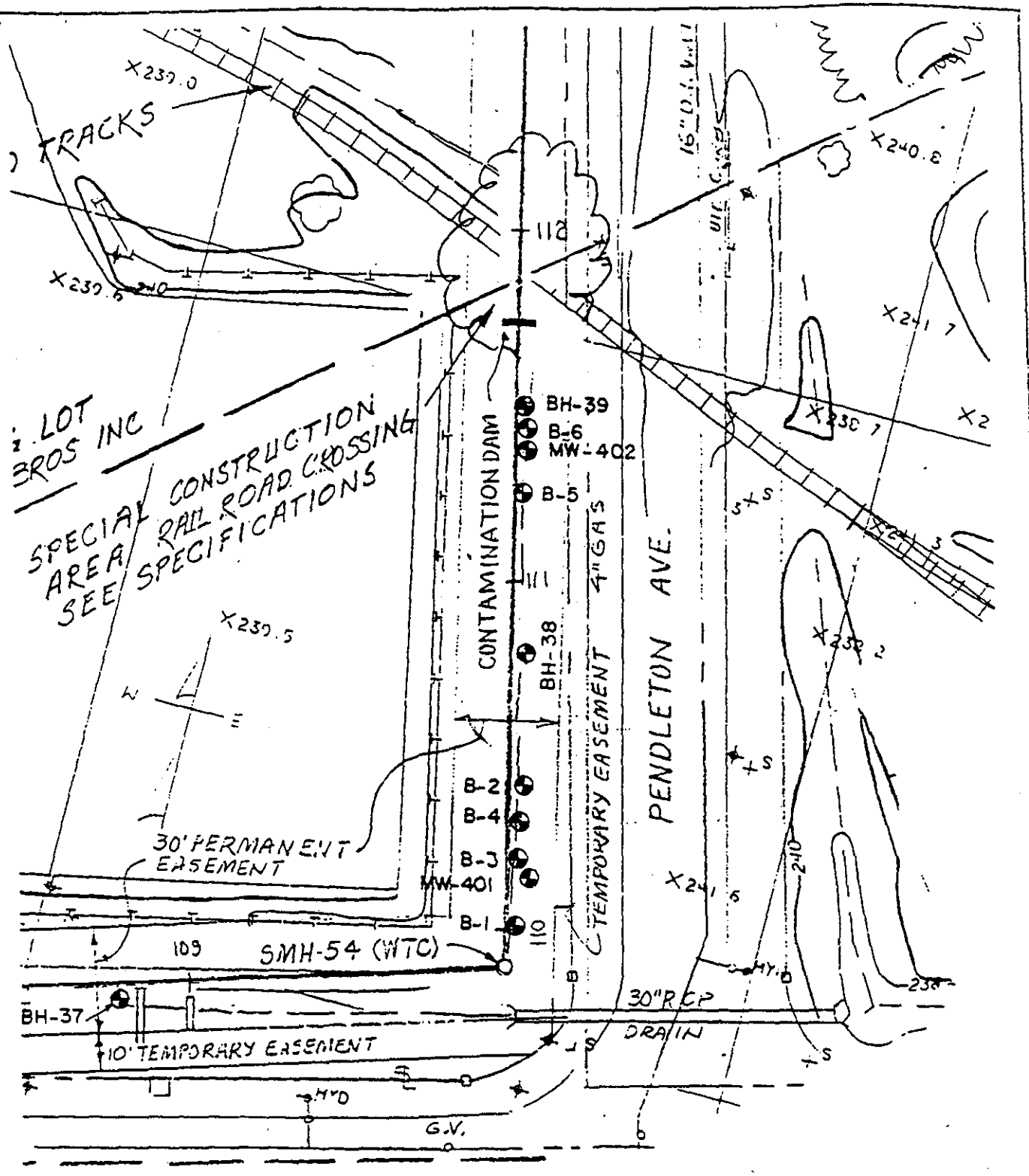
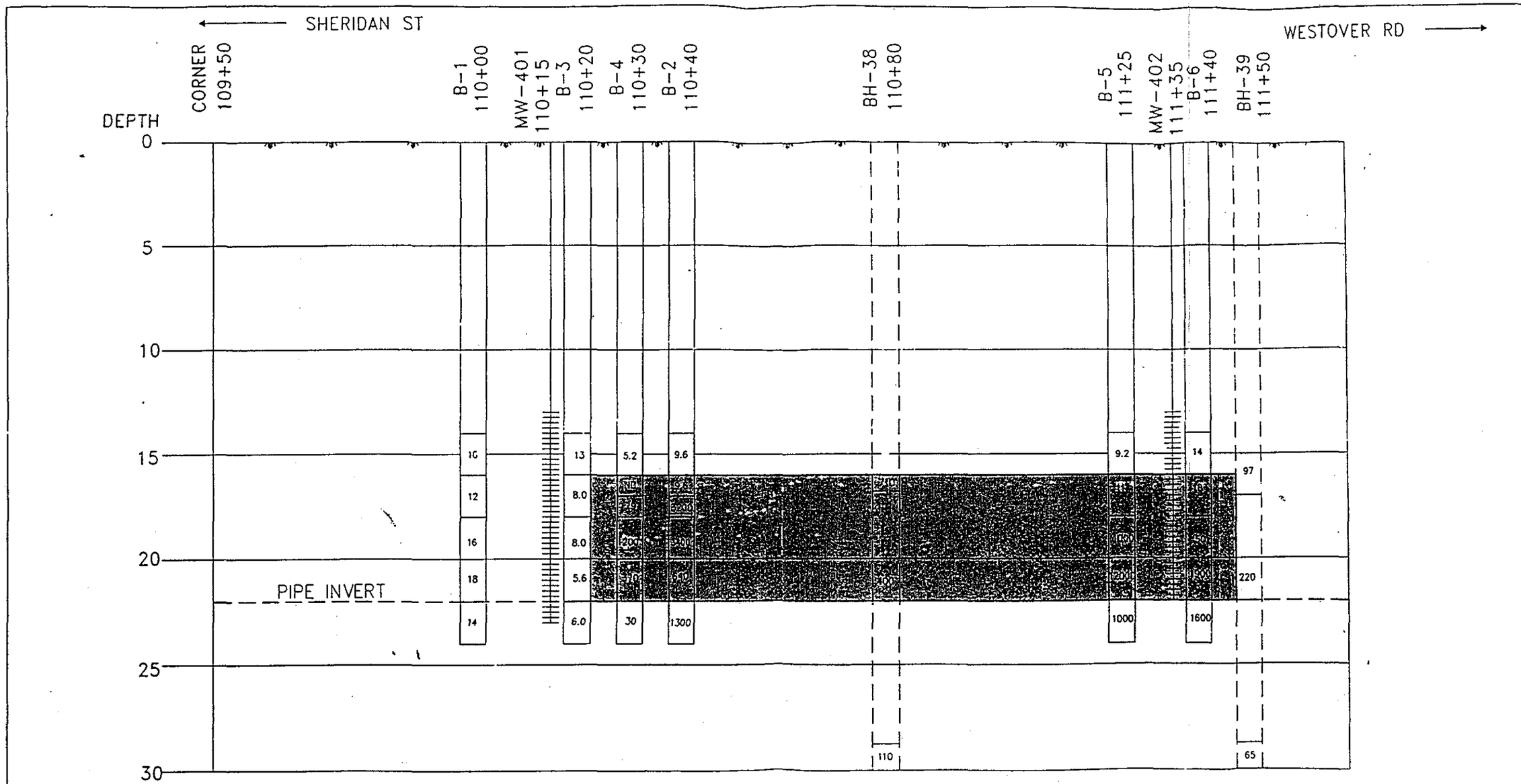


FIGURE 1

ON-SITE TPH ANALYSES
WESTOVER SEWER INTERCEPTOR

TIGHE & BOND, INC. CONSULTING ENGINEERS
WESTFIELD, MASS.
SCALE: 1"=40' DATE MARCH 1991



LEGEND

INDICATES SAMPLES COLLECTED 8/30/90, ANALYZED AT BASE LABORATORY,AND REPORTED TO D.E.P. IN LETTER DATED NOVEMBER 12, 1990

INDICATES SAMPLE SELECTED FOR CONFIRMATION ANALYSES AT BASE LABORATORY

PROPOSED LIMITS OF SOIL TO BE MANIFESTED OFF SITE WITH D.E.P. BILLS OF LADING

NOTES:

1. RESULTS INDICATED ON FIGURE ARE FOR FIELD ANALYSIS OF TOTAL PETROLEUM HYDROCARBONS (TPH), REPORTED IN MG/KG ON A WET WEIGHT BASIS.

2. ALL ON-SITE ANALYSES PERFORMED MARCH 7,1991.

FIGURE NO. 2

ON SITE TPH ANALYSES
WESTOVER SEWER INTERCEPTOR

TIGHE & BOND, INC. CONSULTING ENGINEERS
WESTFIELD, MASS.

H 1"=20'
SCALE: V 1"=10' DATE: MARCH 1991

TETRA·K TESTING

TOTAL PETROLEUM HYDROCARBON REPORT

CLIENT:
Tighe & Bond Engineers
53 Southampton Road
Westfield, MA 01085

PROJECT:
Westover Interceptor
Chicopee, MA

Sample Matrix: SOIL

RESULTS

SAMPLE	SAMPLE DEPTH(ft)	COLLECTION DATE	ANALYSIS DATE	TPH CONC. mg/kg
B-1 S-1	14-16	3/7/91	3/7/91	16
B-1 S-2	16-18	3/7/91	3/7/91	12
B-1 S-3	18-20	3/7/91	3/7/91	16
B-1 S-4	20-22	3/7/91	3/7/91	18
B-1 S-5	22-24	3/7/91	3/7/91	14
B-2 S-1	14-16	3/7/91	3/7/91	9.6
B-2 S-2A	16-17	3/7/91	3/7/91	9.6
B-2 S-2B	17-18	3/7/91	3/7/91	3200
B-2 S-3	18-20	3/7/91	3/7/91	3400
B-2 S-4	20-22	3/7/91	3/7/91	640
B-2 S-5	22-24	3/7/91	3/7/91	1300
B-3 S-1	14-16	3/7/91	3/7/91	13
B-3 S-2	16-18	3/7/91	3/7/91	8.0
B-3 S-3	18-20	3/7/91	3/7/91	8.0
B-3 S-4	20-22	3/7/91	3/7/91	5.6
B-3 S-5	22-24	3/7/91	3/7/91	6.0
B-4 S-1	14-16	3/7/91	3/7/91	5.2
B-4 S-2A	16-17	3/7/91	3/7/91	ND
B-4 S-2B	17-18	3/7/91	3/7/91	79
B-4 S-3	18-20	3/7/91	3/7/91	1200
B-4 S-4	20-22	3/7/91	3/7/91	370
B-4 S-5	22-24	3/7/91	3/7/91	30
B-5 S-1	14-16	3/7/91	3/7/91	9.2
B-5 S-2	16-18	3/7/91	3/7/91	11
B-5 S-3	18-20	3/7/91	3/7/91	1000
B-5 S-4	20-22	3/7/91	3/7/91	12000
B-5 S-5	22-24	3/7/91	3/7/91	1000
B-6 S-1	14-16	3/7/91	3/7/91	14
B-6 S-2	16-18	3/7/91	3/7/91	18
B-6 S-3	18-20	3/7/91	3/7/91	50
B-6 S-4	20-22	3/7/91	3/7/91	1900
B-6 S-5	22-24	3/7/91	3/7/91	1600

METHOD:

Field analysis was conducted in a mobile laboratory using a HORIBA OCMA 220 Infra red Spectrophotometer. Sample extraction was conducted using the shaker method and 1,1,2-Trichloro-1,2,2-Trifluoroethane (FREON 113) as a solvent.

COMMENTS:

All sample results reported in mg/kg on a wet weight basis.
DETECTION LIMIT=4.0 mg/kg.

Reviewed by: 3/18

TIGHE & BOND, INC.

Westfield Executive Park
53 Southampton Road
Westfield, MA 01085
TEL. 413-562-9193
FAX. 413-562-5317

FATE AND TRANSPORT MODELLING FOR PLUMES AT FORMER WESTOVER AIR FORCE BASE

Introduction. Past leaks of primarily fuel-related compounds at the former Westover AFB have resulted in the formation of several groundwater plumes that are slowly migrating toward Cooley Brook, a tributary of the Chicopee River. Several of these plumes have been investigated, with further work planned to completely delineate others. For the plumes that have been identified, it has been suggested that natural attenuation of the plumes is occurring, i.e., primarily through biodegradation of the contaminants in both soils and groundwater. This has been surmised based on the limited extent of the plume relative to the normally expected migration rates based on estimates of groundwater seepage rates, and the growing evidence reported in the literature of the importance of natural attenuation relative to the eventual fate and potential risk posed by fuel-related compounds in groundwater. Most of the work has focussed on the aromatic compounds benzene, toluene, ethylbenzene, and xylenes (BTEX), but the mechanism is common to the degradation of other fuel-related compounds as well as many other organic compounds for which degradation has been identified and quantified in ranges of probable reaction rates.

Purpose. The purpose of this memorandum is to report results of modeling conducted for four plumes (Pumphouses #1, #3, and #6, and Defueling Area #2) identified at the former Westover AFB. This modeling was conducted to estimate potential concentrations of selected compounds identified in these plumes at points of discharge at Cooley Brook. The calculations provide estimates of concentrations in groundwater at the point of discharge, of pore water concentrations in Cooley Brook sediments, of concentrations on the sediments due to partitioning, and of potential concentrations of each plume when mixed with the surface water stream.

The modeling conducted has assumed relatively conservative values for retardation and degradation rates, and, based on observations that plume concentrations appear to have stabilized, likely over-estimates potential effects on Cooley Brook for degradable organic compounds. Selection of parameter values is discussed in the following sections.

Model selection and model input data. The analytical fate and transport model AT123D (Yeh, 1981) was selected as appropriate to the level of available information and the required transport mechanisms to be evaluated. AT123D, although an older model, has remained a versatile assessment tool and is incorporated in USEPA's GEMS (Graphical Exposure Modeling System) risk assessment system of programs (General Sciences Corporation, 1989). This model provides estimates of concentrations in groundwater at the point of discharge. Calculations made to estimate concentrations in sediments and surface water are described later in this memorandum.

Needed model input information includes: source area definition; groundwater flow data (assuming a uniform flow field); dispersion characteristics of the plumes; reaction rates of the chemicals; retardation properties of the aquifer for specific compounds; time-frame for the simulation; and distances to receptor locations. The sources of data and values input to the model are discussed in the following paragraphs.

Source areas for the four plumes have been inferred from limited soil data and the configuration and extent of the plumes themselves. In some areas, it appears that the residual sources in soils have been nearly completely attenuated. For purposes of the modeling, it appeared that source areas for each of the three pumphouse plumes were quite similar, and have been taken as 80 feet wide by 60 long (in the direction of groundwater flow). Thus, one model setup can be used to evaluate each of these three plumes, the difference being the distance to the receptor location, Cooley Brook. For the Defueling Area #2, the plume is somewhat wider, and a source area of 140 feet wide by 60 feet long has been assumed in the model. The extent and size of the source areas is based on interpretations of BTEX compounds only. While other compounds have been detected within these areas, it is unlikely that they share a similar and so extensive a source area. However, to simplify the analysis and to be conservative for these lesser and more sporadically detected compounds, the BTEX plume source area has also been assumed for these other compounds.

For the few inorganic parameters considered (calcium, iron, manganese, sodium and nitrate), a coincident distribution with the fuel plume was assumed. While iron and manganese may likely be present as the result of anaerobic degradation of the fuels, with these metals acting as electron acceptors in the reaction, and hence may be present in a similar distribution as the fuel related contaminants, the presence of calcium, sodium and nitrate may not be directly related to the fuel plumes, but may be derived from road salting or fertilizer applications in the area. For purposes of this analysis, however, they have been assumed to be subject to the same conditions as the fuel-related contaminants in groundwater but with no degradation assumed.

Residual source mass transfer rates are not known, but the model is linear in that an initial concentration that produces a given concentration when modified by some proportion, will see the same proportional variation in the final concentration. For example, if an initial concentration of 10 ppm produces a receptor location concentration of 1 ppm, then an initial concentration of 20 ppm will produce a receptor concentration of 2 ppm, the other conditions in the model remaining constant. This eliminates the need to try to adjust mass loadings into the model to produce matches with observed

conditions, i.e., it is not necessary to calibrate the model to each set of observed concentrations. Any initial concentration can be used to give dilution or attenuation factors for the conditions of the transport, and then this factor can be applied to observed concentrations to estimate receptor location concentrations. The model needs to be run only once for each compound and for each source area.

The mass loading rate to the model has been assumed to be time dependent, with a loss rate of source contaminant taken at 1 percent per month of the residual contaminant mass. This is a discrete representation of a first order decay of the residual source, and is equivalent to about a half-life of 4 years for the residual source. Based on the principal contaminants present, the BTEX compounds, this is probably a conservative rate. An initial estimate of source rate was made to produce concentrations in groundwater of somewhere between 5 and 10 ppm, and this loading schedule (calculated out for monthly values for 15 years) was maintained for all runs. A continuing source for the inorganics was also assumed, primarily for the expected continued mobilization of iron and manganese as the residual fuel constituents continue to degrade over time. This leads to a slightly more conservative estimate of concentrations at Cooley Brook.

The site hydrogeology descriptions in the 1994 GZA report and Lonczak Drive Area study (ABB-ES, 1995) were reviewed for hydrogeologic parameter data. A uniform value of 75 ft/day was taken as the hydraulic conductivity, with a porosity of 0.35, while the gradient was observed to be reported as variable between 0.013 and 0.022 ft/ft. The area topographic map was consulted for approximate stage elevation of Cooley Brook, giving an approximate average horizontal hydraulic gradient of 0.0135 ft/ft between the site and Cooley Brook. This is consistent with the locally reported gradients.

Given the limited extent and reactive nature of the constituents of the plumes, estimation of dispersion coefficients for the aquifer would be extremely difficult to determine from the existing data. Hence, literature values were taken to use in the dispersive component of the model. Values adopted were 168 feet, 21 feet, and 1 foot, respectively, for the longitudinal, transverse. and vertical dispersivities (USEPA, 1990).

Chemical and physical properties of organic chemicals detected in groundwater are given in the following table. Organic carbon partition coefficients (Koc) were taken from USEPA data (USEPA, 1990), while compound reaction half-lives were taken as the low rates reported in groundwater (Howard, 1991) to be conservative in estimating potential impact of organic compounds on Cooley Brook.

APPENDIX D

TABLE 1
PHYSICAL-CHEMICAL PROPERTIES

Chemical	Koc	Retardation	Half-life
benzene	83 ml/g	1.85	20 years
toluene	300	3.95	0.6
ethylbenzene	1100	11.81	0.7
xylenes	240	3.36	1.0
2,4-dimethylphenol	222	3.18	0.038
2-methylnaphthalene	500	84.56	1.0
2-methylphenol	14.8	1.14	0.038
4-methylphenol	17	1.17	0.077
acenaphthene	4600	46.22	2.56
acetone	2.2	1.02	0.038
benzo(b)fluoranthene	550000	5407.5	3.34
benzyl alcohol	110*	2.08*	1.0*
BEHP	5900	59.00	1.066
carbon disulfide	54	1.53	2.0*
chloroform	47	1.46	5.0
dibenzofuran	1230	13.09	0.096
fluoranthene	38000	374.54	2.41
fluorene	7300	72.76	0.329
methylene chloride	8.8	1.09	0.154
naphthalene	1300	13.78	0.71
phenanthrene	14000	38.62	1.14
phenol	14.2	1.14	0.019
pyrene	38000	374.54	10.4

Notes: * - estimated based on available correlations, or for similar compounds

The retardation factor, the rate of groundwater movement compared to that of each particular compound, given above is based on the Koc, the porosity, the bulk density of the aquifer, estimated at 1.72 g/cc, and the fraction organic carbon, foc, taken as 0.002 for a fairly clean sandy aquifer material.

While the migration of the inorganic constituents is dependent on a greater number of geochemical conditions than are the organic compounds, the transport of inorganics through the aquifer has been simplified to assume no significant retardation of contaminant in the

aquifer. Decreases in concentrations occur due to dispersion only. Partitioning to bottom sediments is done as for the organics as described in a later section. The partitioning is described by a soil/water partitioning coefficient (Kd). Values reported for these coefficients for inorganics may vary widely based on soil and other geochemical conditions. A representative value from the literature has been adopted for this evaluation based on review of values reported in Baes and Sharp, the DOE MEPAS model database, and the USEPA STF database. Kd values used for the inorganics reported are: calcium (67 ml/g), manganese (20 ml/g), and iron (11 ml/g), while sodium and nitrate are assumed not to partition based on their extremely high solubilities.

The time-frame for the simulation was taken as 15 years, this being adequate time for plumes to either reach the receptor location at maximum concentration, or for the plume to have stabilized and show a rising then decreasing concentration at some point along the pathway. This time was also arrived at in part calculating the retarded rate of migration of the constituents, and considering the distance from the source areas to expected points of discharge along Cooley Brook. For each of the plumes these approximate distances are as follows: Pumphouse #1, 3300 feet; Pumphouse #3, 3650 feet; Pumphouse #6, 4575 feet; and Defueling Area #2, 4675 feet.

Note that the units of measure used in AT123D are metric for length and hours for time, and the above data values have been converted to the proper units for running the model.

Screening of compounds to be modeled. Based on experience with similar types of analysis, most of the above compounds would be expected to nearly totally degrade given their degradation rates, retardation factors, and the length of the migration pathway. Rather than run the model for every compound, a screening approach was used which used the time of travel (based on retarded velocity) and the compound half-life to estimate the maximum concentration at the point of discharge, i.e., just considering the degradation, which compounds might be expected to survive to discharge at Cooley Brook. Using a cut-off of 0.001 parts per billion (ppb) in the discharging groundwater, only three compounds other than the BTEX compounds passed the screening. These were benzyl alcohol (DF #2), carbon disulfide (PH #3), and chloroform (PH #6). AT123D runs were then made for BTEX and these three other compounds. Results of screening calculations are appended.

Separate runs were also made to represent the assumed non-degraded, unretarded transport of the inorganic constituents.

AT123D Model Results. Table 2 summarizes the results of the AT123D modeling for the organic compounds, giving the expected concentration in groundwater arriving at the expected point of discharge into Cooley Brook, based on assumptions of present day

maximum observed concentrations in source areas (see appended table of hits only concentrations reported for these four plumes), and as potentially producing maximum concentrations in sediment pore water and on sediments, and in the surface water after the plume discharge mixes with Cooley Brook. The methods used to estimate these other concentrations are described in the following sections of this memorandum.

These estimated concentrations are based on the arrival of maximum concentrations originating in the source area, except for the surface water concentration which is based on the average concentration (at the time of maximum concentrations at that location) since complete mixing in the stream is assumed. Surface water concentrations are given for each plume, and the total in the stream would be the sum of these. Maximum sediment concentrations establish a range depending on sediment conditions, and exposure scenarios should also consider the average sediment concentrations which would be one-fifth of the tabulated values. The same is also true for the pore water concentrations (i.e., the average relative to the maximum). This is discussed in greater detail below. For compounds screened out, expected concentrations in pore water, sediments, and surface water are all expected to be much less than 0.001 ppb.

Table 3 provides similar estimated concentrations for calcium, iron, manganese, sodium, and nitrate, where detected in the individual plumes. Calculations were made in the same manner as for the organic compounds, except that the literature Kd value was used instead of the product of foc times Koc. For the inorganics such as manganese and iron, the estimates calculated are likely to represent extreme maximums as the mobility of these constituents is affected by the pH and oxidation-reduction potential in the aquifer. Conditions for mobility will change along the migration pathway, and as concentrations and biological activity decrease, iron and manganese may precipitate out, further decreasing concentrations. Further, and particularly for iron, maximum concentrations at the source areas have generally been total metal analyses, which are typically greater than the dissolved concentrations. While some colloidal transport may occur, for iron it is more probable that iron flocs would occur and not migrate with the dissolved contaminants. Thus the evaluation, based on the total metals analysis is likely conservative for expected concentrations at Cooley Brook. Lastly, recall that the concentrations of calcium, sodium and nitrate may not be related to the fuel-associated plumes.

Estimation of sediment concentrations. For ecological receptors, concentrations were estimated for sediment pore-water as well as expected concentrations of compounds partitioned to sediments were calculated for those compounds exceeding the screening evaluation. Concentrations in sediments will depend on many factors, especially the organic

content of the sediments, the mass of sediments present at the point of discharge, and the mobility of these sediments (i.e., do they readily scour, presenting fresh sediments for subsequent partitioning?). Contaminants in groundwater emerging into relatively clean sediments will partition according to the following expression:

$$n*Cw = n*Cp + rhob*Cs \quad (1)$$

where:

n is the porosity
Cw is the groundwater concentration
Cp is the pore water concentration
rhob is the sediment bulk density
and Cs is the concentration sorbed to the sediment.

This equation can be solved since we know or can assume values for n and rhob for the sediment (assumed to be 0.5 and 1.33 g/cc, respectively), and Cp and Cs are related by the linear partitioning coefficient:

$$Cs = Cp*Kd = Cp*foc*Koc \quad (2)$$

where:

Kd is the soil/sediment partition coefficient
foc is the fraction organic carbon (assumed to be 0.01)
and Koc is the organic carbon partition coefficient.

Equation (1) is essentially a mass balance with the left side being the mass into a representative element, and the right side terms being how the mass partitions into the water and solid phases, respectively. The resultant water and sediment concentrations appear in the table as the pore water concentration, Cp, and the lower sediment concentration, Csl.

If the sediments are immobile, but limited in mass, concentrations may build up on the solid and the mass unable to sorb added contaminant. In this case, we would expect to see concentrations in the pore water equal to those in the groundwater discharge, and equilibrium concentrations in the sediment equal to the water concentration times the partition coefficient. Partitioning would still occur, but the rates of sorption and desorption would be equal. In this case, the pore water would be equal to the groundwater concentration, and the sediment concentration would be as given by equation (2) above.

These ranges of concentrations are given in Table 2, for the water as the groundwater concentration, Cw, and the pore water concentration, Cp, and for the sediments as the lower

sediment concentration, Csl, and the upper sediment concentration, Csu. These reflect the maximums, whereas average values across the plume discharge section would be about one-fifth the maximums, assuming a gaussian distribution for the plume cross-section.

Concentrations in surface water. Concentrations in surface water resulting from the discharge of each of the plumes can be estimated by taking the estimated average concentration of each of the discharging compounds times the volumetric discharge rate of the plume and diluting it into the estimated flow of Cooley Brook. Flow in Cooley Brook was estimated by approximating the watershed area for the brook, about 3.22 square miles, and multiplying it by the average discharge per watershed area derived from the nearest USGS gaged stream, the Chicopee River at Indian Orchard, about 2.4 miles from the site. This factor was calculated as 1.31 cfs per square mile (USGS, 1992). This value may be somewhat low as the Chicopee is dammed and used as water supply along its length, but affords another element of conservatism to the analysis. Applying this factor to the estimated watershed area for Cooley Brook gives an estimate of 4.2 cfs as annual average flow. In calculating the concentration of plume discharging to Cooley Brook, sediments were conservatively assumed to be of insufficient mass to appreciable reduce groundwater concentrations, and Cw was used as the maximum concentration, with a factor of one-fifth applied to get a plume average. Although plume dimensions will likely shrink due to degradation as the plume approaches Cooley Brook, a cross-sectional of 500 feet wide by 60 feet thick was assumed in order to be conservative and allow for the uncertainty in the dispersivity values. Based on these dimensions, and an estimated groundwater velocity of 1056 feet per year, and a porosity of 0.35, each plume discharge is about 0.35 cfs. The estimated dilution factor for a plume discharging into the brook is then

$$\text{Dilution} = (\text{Cmax}/5)\ [(0.35)/(0.35+4.2)] = \text{Cmax}/65$$

or, the expected concentration in surface water would be 1/65th of the maximum estimated groundwater concentration for an annual average. Concentrations would be additive for determining the combined effect of all four plume discharges.

REFERENCES AND BIBLIOGRAPHY

ABB Environmental Services, Inc., 1994. Phase I Site Investigation Report, Lonczak Drive Study Area, Former Westover Air Force Base, Chicopee, Massachusetts. Prepared for the U.S. Army Corps of Engineers, New England Division. January 1995.

Baes, C. and Sharp, R., 1983. A Proposal for Estimation of Soil Leaching and Leaching Constants for Use in Assessment Models. J. Environ. Qual., Vol. 12, No. 1, pp. 17-28.

Battelle/DOE, 1994. MEPAS - Multimedia Environmental Pollutant Assessment System (MEPAS) Application Guidance. Volume 2 - Guidance for Evaluating MEPAS Input Parameters for Version 3.1. November 1994.

General Sciences Corporation, 1989. PCGEMS User's Guide, Release 1.0, Prepared for USEPA Office of Pesticides and Toxic Substances Exposure Evaluation Division. Laurel, MD.

GZA, 1994. Final Phase II Investigatory Field Report. Comprehensive Site Assessment Former Westover Air Force Base, Chicopee, Massachusetts, Site No. 1-0299, Vol. 1., Prepared for United States Army Corps of Engineers. August 1994.

Howard, P., ed., 1991. Handbook of Environmental Degradation Rates, Lewis Publishers, Chelsea, MI.

USGS, 1992. Water Resources Data: Massachusetts and Rhode Island, Water Year 1991. U. S. Geological Survey Water-Data Report MA-RI-91-1.

USEPA, 1990. Multimedia Exposure Assessment Model (MULTIMED) for Evaluating the Land Disposal of Wastes -- Model Theory. ERL, Athens, GA.

USEPA, 1991. Soil Transport and Fate Database 2.0 and Model Management System. (Simms, et al.) Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, USEPA, Ada, OK.

Yeh, G., 1981. AT123D: Analytical Transient One-, Two-, and Three-Dimensional Simulation of Waste Transport in the Aquifer System. ORNL-5602, Oak Ridge National Laboratory, Oak Ridge, TN.

TABLE 2
MODELLING RESULTS
ORGANIC COMPOUNDS
CONCENTRATIONS IN PPB

Area/Compound	Max Conc	Cw	Cp	Csl	Csu	Csw
DF #2						
Benzene	1800	5.2	1.6	1.3	4.3	0.1
Toluene	13000	0.0	0.0	0.0	0.0	0.0
Ethylbenzene	1800	0.0	0.0	0.0	0.0	0.0
Xylenes	9100	0.0	0.0	0.0	0.0	0.0
Benzyl alcohol	75	0.01	0.003	0.0033	0.013	0.00018
Pumphouse #1						
Benzene	0	0.0	0.0	0.0	0.0	0.0
Toluene	300	0.0	0.0	0.0	0.0	0.0
Ethylbenzene	400	0.0	0.0	0.0	0.0	0.0
Xylenes	1400	0.2	0.03	0.06	0.48	0.003
Pumphouse #3						
Benzene	0	0.0	0.0	0.0	0.0	0.0
Toluene	8	0.0	0.0	0.0	0.0	0.0
Ethylbenzene	1000	0.0	0.0	0.0	0.0	0.0
Xylenes	5700	0.6	0.08	0.2	1.44	0.009
Carbon disulfide	6	0.05	0.02	0.01	0.03	0.0003
Pumphouse #6						
Benzene	80	0.2	0.06	0.05	0.166	0.003
Toluene	3000	0.0	0.0	0.0	0.0	0.0
Ethylbenzene	1800	0.0	0.0	0.0	0.0	0.0
Xylenes	14000	0.0	0.0	0.0	0.0	0.0
Chloroform	6	0.09	0.04	0.02	0.044	0.0006

Notes:
Cw is concentration in groundwater at point of discharge
Cp is concentration in pore water
Csl is low concentration in sediments
Csu is high (upper) concentration in sediments
Csw is concentration in surface water

TABLE 3
MODELLING RESULTS
INORGANIC COMPOUNDS
CONCENTRATIONS IN PPB

Area/Compound	Max Conc	Cw	Cp	Csl	Csu	Csw
DF #2						
Calcium	7400	383.4	2.14	143.4	25688	5.9
Iron	23500	1218	40.2	442	13398	18.7
Manganese	500	25.9	0.5	9.6	518	0.4
Sodium	5000	259	259	-	-	4
Nitrate	170	8.8	8.8	-	-	0.14
Pumphouse #1						
Calcium	-	-	-	-	-	-
Iron	203*	13.9	0.46	5.1	153	0.21
Manganese	406*	27.8	0.51	10.2	556	0.43
Sodium	5580*	382	382	-	-	5.9
Nitrate	-	-	-	-	-	-
Pumphouse #3						
Calcium	9500	590	3.3	221	39530	9.1
Iron	136000	8447	279	3069	92917	130
Manganese	210	13	0.24	4.8	260	0.2
Sodium	8500	528	528	-	-	8.1
Nitrate	160	9.9	9.9	-	-	0.15
Pumphouse #6						
Calcium	12000	580	3.2	214	38860	8.9
Iron	32400	1565	51.7	569	17215	24.1
Manganese	677*	32.7	0.6	12.1	654	0.5
Sodium	29800	1440	1440	-	-	22.2
Nitrate	-	-	-	-	-	-

Notes:
Cw is concentration in groundwater at point of discharge
Cp is concentration in pore water
Csl is low concentration in sediments
Csu is high (upper) concentration in sediments
Csw is concentration in surface water
* denotes filtered sample

SAMPLE CALCULATIONS AND SAMPLE MODEL RESULTS

PROJECT	COMP. BY	JOB NO.
Westover – EPCs for Cooley Brook; PH #1, #3, #6 and DFA #2 plumes	RAL	9904-03
	CHK. BY NSG	DATE 4/4/96

Transport modeling for former Westover base plumes

1. Aquifer properties

GZA Phase II; ABB Lonczak Drive reports

porosity 0.3 to 0.4 ⇒ use 0.35

K between 50 and 100 ft/d ⇒ use K = 75 ft/d

$i \approx 0.0025$ to 0.01 ft/ft

$v \approx$ 0.4 to 3.0 ft/d (150 to 1100 ft/yr)

Overall gradient from sites to Cooley Brook $\approx \frac{216-170}{3400} = 0.0135 \frac{ft}{ft}$.
Elevation of Cooley Brook taken from USGS topo map.

Approximate groundwater flow rate:

$$v = \frac{Ki}{n} = \frac{(75 ft/d)(0.0135)}{0.35} = 2.9 ft/d \Rightarrow 1056 ft/yr.$$

2. Source Areas

Pumphouse #1 – approx source area 80' wide x 50' long
distance to Cooley Brook ~ 3300' (1016 m)

Pumphouse #3 – approx source area 70' wide x 60' long
distance to Cooley Brook ~ 3645' (1111 m)

Pumphouse #6 – approx source area 80' wide x 60' long
distance to Cooley Brook ~ 4583' (1397 m)

Defueling Area #2 – approx source area 140' wide x 60' long
distance to Cooley Brook ~ 4687' (1428 m)

Due to similarity of PH source areas, lump these all in a single model run with source area ~ 80' x 60' (24m x 18m)
Differences will occur in AT123D due to different distances to receptor (Cooley Brook).

Run DFA #2 plume separately

8. Transport Parameters

No foc/TOC data; assume 0.002 for aquifer and 0.01 for Cooley Brook sediments.

Use conservative distance of 3400' to receptor for all plumes (would increase with lower concentrations for greater distances because of dispersivity–distance correlation).

From USEPA guidance (1990),

$$\alpha_L(d=x) = \alpha_L(d=500')\left(\frac{x}{500'}\right)^{1/2}$$

or, in meters, where $\alpha_L(d=500') = 19.86\ m$

$$\alpha_L(d=3400') = 19.86\ m\left(\frac{3400}{500}\right)^{1/2} = 51.8\ m$$

$$\alpha_T = \frac{\alpha_L}{8} = 6.48\ m$$

$$\alpha_z = \frac{\alpha_L}{160} = 0.32\ m$$

Retardation (aquifer)

$$R = 1 + \frac{\rho_b K_{oc} f_{oc}}{n}$$

where $\rho_b = 2.65(1-n) = 2.65(1-0.35) = 1.72\ \frac{g}{cc}$

$$R = 1 + \frac{(1.72)(0.002)K_{oc}}{0.35} = 1 + 0.0983\,K_{oc}$$

Retardation (sediments)

assume $n = 0.5$ for sediments and

$$\rho_b = 2.65(1-0.5) = 1.33\ \frac{g}{cc}$$

with f_{oc} assumed as 0.01

$$R = 1 + \frac{(1.33)(0.01)}{0.5}K_{oc} = 1.0266$$

For half-lives of individual compounds (and K_{oc} values) see Table 1 of the text.

4. Screening of compounds

While BTEX compounds were the principal contaminants detected, several other compounds were identified in groundwater associated with each of the plumes. In order to limit the number of compounds and AT123D runs made for each plume, compounds were screened by assuming only degradation occurs along the migration pathway (no dilution by dispersion). Only compounds with screening concentrations reaching Cooley Brook (in addition to BTEX) at above 0.001 ppb in groundwater were run using the model. Screening results (including expected sediment and surface water concentrations are calculated and appended). A sample calculation for the groundwater is:

$$\text{Travel time} = \left(\frac{\text{receptor distance}}{\text{groundwater velocity}}\right) * \text{Retardation}$$

$$\text{Final concentration} = \text{Initial concentration} / 2^{N}$$

where N = number of half lives = Travel time / half-life

for DFA #2 and 2,4-dimethylphenol

$$\text{Travel time} = \left(\frac{4687\,ft}{1056\,ft/yr}\right)\left(1 + .00983(222)\right) = 13.99\,yrs$$

$$N = (13.99\,yrs / 0.038\,yr) = 368.2$$

$$\text{Final conc} = (61\,ppb)/2^{368.2} = \frac{61\,ppb}{10^{110.8}} \cong 1.0\,(10^{-110})\,ppb$$

Any numbers less than 10^{-3} ppb suggest probable complete degradation before discharge to surface water.

As a result of this screening process, additional runs were made for benzyl alcohol for DFA #2, carbon disulfide for PH #3, and chloroform for PH #6. While all of these compounds were only sporadically detected, model runs were made assuming the same source area as for the entire plume. This is undoubtably conservative.

PROJECT	COMP. BY	JOB NO.
Westover - EPCs for Cooley Brook	RAL	9904-03
	CHK. BY NSG	DATE 4/4/96

4056

5. Partitioning to sediments

A range of conditions is considered. First, sediments are transient and mobile. This suggests the sediments are exposed to a discharging plume only temporarily, and concentrations will be established between pore water and sediment, the porewater concentration being less than the groundwater concentration due to partitioning. At the other extreme, sediments remain in place and concentrations in porewater continue to rise to be the maximum groundwater concentration.

In the first case, we can write a mass balance between the entering groundwater and the resultant partitioning in the pore water and to the sediments.

$$\theta C_w = \theta C_p + \rho_b C_s$$

where

θ = porosity, take as 0.5
C_w = concentration of groundwater at point of discharge $\mu g/cm^3$
C_p = resultant pore water concentration, $\mu g/cm^3$
C_s = concentration on sediments, $\mu g/g$
ρ_b = bulk density, g/cc; take as 2.65(1-.5) = 1.33

Also assuming linear partitioning,

$$C_s = C_p K_d = C_p \cdot f_{oc} \cdot K_{oc}, \text{ taking } f_{oc} \text{ as } 0.01$$

$$\therefore \theta C_w = C_p(\theta + \rho_b f_{oc} K_{oc})$$

$$C_w = C_p R \quad \text{and} \quad C_p = \frac{C_w}{R} = \frac{C_w}{1 + 0.026 K_{oc}}$$

$$\text{and } C_s = C_p(.01) K_{oc}$$

This establishes a lower expected maximum concentration for pore water and sediment

The upper bound for C_p is C_w, with a corresponding upper bound for sediments.
The sediment bounds are indicated by C_{sl} and C_{su}.

Sample calculation:

DFA*Z for 2,4-dimethylphenol

$$C_p = \frac{C_w}{1 + .0266(222)} = \frac{1.0(10^{-110})}{6.9} \approx 1.4(10^{-111})$$

$$C_{sl} = (.01)(222)(1.4)(10^{-111}) \cong 3.1(10^{-111})$$

$$C_{su} = C_p K_d = 1.0(10^{-110})(2.22) \cong 2.2(10^{-110})$$

↑ take as 0.01 K_{oc} for sediments

6. Surface Water Concentrations

A rough watershed area for Cooley Brook was drawn on a topo map and estimated as 3.22 square miles to the point where plumes might be expected to discharge.

It is not believed that Cooley Brook flow has been measured, so this was estimated from flow and drainage area from the nearest USGS gaging station. These data are:

USGS Gaging Station 01177000 Chicopee River @ Indian Orchard

Annual mean flow = 900 cfs
Drainage area = 689 mi^2

$$\text{Factor} = \frac{900 \text{ cfs}}{689 \text{ mi}^2} = 1.31 \text{ cfs/mi}^2$$

It is noted that the Chicopee River has several reservoirs, which may make this an underestimate for unimpounded, unused streams, such as the upper reaches of Cooley Brook.

The annual average flow for Cooley Brook would then be:

$$(3.22 \text{ mi}^2)\left(1.31 \frac{\text{cfs}}{\text{mi}^2}\right) = 4.2 \text{ cfs.}$$

Estimating a dilution factor in surface water:

While the plumes will degrade as they move, and may eventually shrink based on some concentration ISO contour, plumes are assumed in this analysis to reach a width of 500' and a thickness of 60' at the point of discharge. The concentration distribution for this cross-section is assumed to be Gaussian, with the result that the average concentration is about ½ the maximum concentration. Given these dimensions and the flow rate of 1056 ft/yr, each plume flux is about:

$$(500\,ft)(60\,ft)(1056\,ft/yr)(0.35) = 11.1(10^6)\,ft^3/yr$$

(0.35 = porosity)

$$= 0.35\,cfs$$

In-stream concentrations would be

$$C_{sw} = \frac{C_w(max)}{5}\left[\frac{0.35\,cfs}{0.35\,cfs + 4.2\,cfs}\right] \cong \frac{C_w(max)}{65}$$

Note that the estimated C_{sw} is based on the conservative assumption that sediments are not massive enough to sorb all contaminants in groundwater. If they are, the C_{sw} would be lower, i.e., replacing $C_w(max)$ by $C_p(max)$.

Example calculation:

DFA #2, 2,4-dimethylphenol

$$C_{sw} = \frac{1.0\,(10^{-110})}{65} \approx 1.5(10^{-112})\,ppb$$

Estimated C_{sw} are shown on Table 2 for model run compounds, and appended for compounds eliminated by screening.

Screening Results
Concentrations in ppb/ug/L

Area/Compound	Max conc	Cw	Cp	Csl	Csu	Csw
DFA #2						
2,4-dimethylphenol	61	1.0e-110	1.4e-111	3.1e-111	2.2e-110	1.5e-112
2-methylnaphthalene	74	7.4e-111	3.3e-109	2.7e-111	6.3e-109	1.1e-112
2-methylphenol	94	1.8e-38	1.3e-38	2.0e-39	3.0e-39	2.8e-40
acetone	460	1.3e-33	1.2e-33	3.0e-35	3.0e-35	2.0e-35
benzo(b)fluoranthene	2	1.2e-2144	8.0e-2149	4.0e-2145	6.6e-2141	1.8e-2146
benzyl alcohol	75	0.13	Model run made			
BEHP	25	1.3e-74	8.0e-77	5.0e-75	8.0e-73	2.0e-76
fluoranthene	1	1.4e-206	1.4e-209	5.3e-207	5.3e-204	2.2e-208
methylene chloride	690	2.9e-7	2.3e-7	2.0e-8	3.0e-8	4.5e-9
naphthalene	150	3.0e-24	8.0e-26	1.0e-24	3.9e-23	4.6e-26
phenanthrene	2	2.5e-167	6.7e-170	9.4e-168	3.5e-165	3.8e-169
phenol	10	3.5e-79	2.5e-79	3.6e-80	5.0e-80	5.4e-81
pyrene	1	2.0e-48	2.0e-51	7.6e-49	7.6e-45	3.1e-50
PH #1						
acetone	16	5.7e-25	5.4e-25	1.0e-26	1.0e-26	8.8e-27
methylene chloride	2	4.0e-7	3.0e-7	3.0e-8	4.0e-8	6.2e-9
PH #3						
2,4-dimethylphenol	8	1.0e-86	1.4e-87	3.0e-87	2.2e-86	1.5e-88
2-methylnaphthalene	68	1.1e-86	4.8e-89	4.1e-87	9.4e-85	1.7e-88
4-methyl-2-pentanone	80	1.3e-31	8.0e-32	1.7e-30	2.6e-30	2.0e-33
4-methylphenol	9	1.5e-15	1.0e-15	2.0e-16	3.0e-16	2.3e-17
acetone	310	4.2e-26	4.0e-26	9.0e-28	8.0e-28	6.5e-28
BEHP	1	3.0e-58	2.0e-60	1.0e-58	1.8e-56	4.6e-60
carbon disulfide	6	1.0	Model run made			
methylene chloride	86	3.8e-6	3.1e-6	2.7e-7	3.3e-7	5.8e-8
naphthalene	96	6.8e-19	1.9e-20	2.5e-19	8.8e-18	1.0e-20
PH #6						
2,4-dimethylphenol	7	3.4e-109	5.0e-110	1.1e-109	7.5e-109	5.2e-111
2-methylnaphthalene	500	1.7e-108	7.5e-111	6.4e-109	1.4e-106	2.6e-110
4-methylphenol	8	1.1e-19	8.0e-20	1.4e-20	1.9e-20	1.7e-21
acetone	230	2.0e-33	1.9e-33	4.2e-35	4.4e-35	3.1e-35
BEHP	39	2.0e-71	1.2e-73	7.1e-72	1.2e-69	3.0e-73
methylene chloride	1300	7.3e-7	5.9e-7	5.0e-8	6.0e-8	1.1e-8
naphthalene	360	1.6e-23	4.5e-25	5.8e-24	2.1e-22	2.5e-25
acenaphthalene	2	3.0e-108	2.0e-110	9.2e-109	1.4e-106	4.6e-110
chloroform	6	2.5	Model run made			
dibenzofuran	1	8.0e-179	2.0e-178	3.0e-177	1.0e-177	1.2e-180
fluorene	1	1.2e-289	6.1e-292	4.4e-290	8.8e-288	1.8e-291
phenanthrene	1	2.4e-165	6.4e-168	9.0e-166	3.4e-163	3.7e-167
2-methylphenol	11	7.1e-39	5.1e-39	8.0e-40	1.1e-39	1.1e-40

See text Table 2 for identification of terms.

Pumphouses 1, 3, 6 BTEX Plume Run 1 3/22/96□ benzene□□□□□□□□□□□□□□□□□□□□

NO. OF POINTS IN X-DIRECTION 10
NO. OF POINTS IN Y-DIRECTION 10
NO. OF POINTS IN Z-DIRECTION 1
NO. OF ROOTS & NO. OF SERIES TERMS 400
NO. OF BEGINNING TIME STEPS 13
NO. OF ENDING TIME STEP 181
NO. OF TIME INTERVALS FOR PRINTED OUT SOLUTION 12
INSTANTANEOUS SOURCE CONTROL = 0 FOR INSTANT SOURCE 1
SOURCE CONDITION CONTROL = 0 FOR STEADY SOURCE 0
INTERMITTENT OUTPUT CONTROL = 0 NO SUCH OUTPUT 2
CASE CONTROL =1 THERMAL, = 2 FOR CHEMICAL, = 3 RAD

AQUIFER DEPTH, = 0.0 FOR INFINITE DEEP (METERS) ...100.000000
AQUIFER WIDTH, = 0.0 FOR INFINITE WIDE (METERS) ... 0.000000
BEGIN POINT OF X-SOURCE LOCATION (METERS) ..... -9.000000
END POINT OF X-SOURCE LOCATION (METERS) 9.000000
BEGIN POINT OF Y-SOURCE LOCATION (METERS) .....-12.000000
END POINT OF Y-SOURCE LOCATION (METERS) 12.000000
BEGIN POINT OF Z-SOURCE LOCATION (METERS) 0.000000
END POINT OF Z-SOURCE LOCATION (METERS) 2.400000

POROSITY 0.350000
HYDRAULIC CONDUCTIVITY (METER/HOUR) 0.950000
HYDRAULIC GRADIENT 0.013500
LONGITUDINAL DISPERSIVITY (METER) 51.799999
LATERAL DISPERSIVITY (METER) 6.500000
VERTICAL DISPERSIVITY (METER) 0.300000
DISTRIBUTION COEFFICIENT, KD (M**3/KG) 0.000166
HEAT EXCHANGE COEFFICIENT (KCAL/HR-M**2-DEGREE C) . 0.000000

MOLECULAR DIFFUSION MULTIPLY BY TORTUOSITY(M**2/HR) 0.0000E+00
DECAY CONSTANT (PER HOUR) 0.3960E-04
BULK DENSITY OF THE SOIL (KG/M**3) ..... 0.1720E+04
DENSITY OF WATER (KG/M**3) ..... 0.1000E+04
ACCURACY TOLERANCE FOR REACHING STEADY STATE 0.1000E-01
TIME INTERVAL SIZE FOR THE DESIRED SOLUTION (HR) .. 0.7300E+03
DISCHARGE TIME (HR) ..... 0.1314E+06
WASTE RELEASE RATE (KCAL/HR), (KG/HR), OR (CI/HR) . 0.0000E+00

0.0000E+000.1524E+030.3048E+030.4572E+030.6096E+030.7620E+030.9142E+030.1016E+04
0.1111E+040.1397E+04
0.0000E+000.3048E+020.6096E+020.9144E+020.1219E+030.1524E+030.1829E+030.2134E+03
0.2438E+030.2743E+03
0.0000E+00

0 LIST OF TRANSIENT SOURCE RELEASE RATE

0.5830E-010.5770E-010.5710E-010.5660E-010.5600E-010.5540E-010.5490E-010.5430E-01
0.5380E-010.5320E-010.5270E-010.5220E-010.5170E-010.5120E-010.5060E-010.5010E-01
0.4960E-010.4910E-010.4860E-010.4820E-010.4770E-010.4720E-010.4670E-010.4630E-01
0.4580E-010.4530E-010.4490E-010.4440E-010.4400E-010.4360E-010.4310E-010.4270E-01
0.4230E-010.4180E-010.4140E-010.4100E-010.4060E-010.4020E-010.3980E-010.3940E-01
0.3900E-010.3860E-010.3820E-010.3780E-010.3750E-010.3710E-010.3670E-010.3640E-01
0.3600E-010.3560E-010.3530E-010.3490E-010.3460E-010.3420E-010.3390E-010.3350E-01
0.3320E-010.3290E-010.3250E-010.3220E-010.3190E-010.3160E-010.3120E-010.3090E-01
0.3060E-010.3030E-010.3000E-010.2970E-010.2940E-010.2910E-010.2880E-010.2850E-01
0.2820E-010.2800E-010.2770E-010.2740E-010.2710E-010.2690E-010.2660E-010.2630E-01
0.2610E-010.2580E-010.2560E-010.2530E-010.2500E-010.2480E-010.2450E-010.2430E-01
0.2400E-010.2380E-010.2360E-010.2330E-010.2310E-010.2290E-010.2260E-010.2240E-01
0.2220E-010.2200E-010.2170E-010.2150E-010.2130E-010.2110E-010.2090E-010.2070E-01
0.2050E-010.2030E-010.2010E-010.1990E-010.1970E-010.1950E-010.1930E-010.1910E-01
0.1890E-010.1870E-010.1850E-010.1830E-010.1820E-010.1800E-010.1780E-010.1760E-01
0.1740E-010.1720E-010.1710E-010.1690E-010.1670E-010.1660E-010.1640E-010.1620E-01
0.1610E-010.1590E-010.1570E-010.1560E-010.1540E-010.1530E-010.1510E-010.1500E-01
0.1480E-010.1470E-010.1450E-010.1440E-010.1420E-010.1410E-010.1400E-010.1380E-01
0.1370E-010.1360E-010.1340E-010.1330E-010.1320E-010.1300E-010.1290E-010.1280E-01
0.1260E-010.1250E-010.1240E-010.1220E-010.1210E-010.1200E-010.1190E-010.1180E-01
0.1160E-010.1150E-010.1140E-010.1130E-010.1120E-010.1110E-010.1100E-010.1090E-01
0.1080E-010.1060E-010.1050E-010.1040E-010.1030E-010.1020E-010.1010E-010.1000E-01
0.9900E-020.9800E-020.9700E-020.9600E-02

0

RETARDATION FACTOR ..... 0.1816E+01
RETARDED DARCY VELOCITY (M/HR) 0.2018E-01
RETARDED LONGITUDINAL DISPERSION COEF. (M**2/HR) .. 0.1045E+01
RETARDED LATERAL DISPERSION COEFFICIENT (M**2/HR) . 0.1312E+00
RETARDED VERTICAL DISPERSION COEFFICIENT (M**2/HR) 0.6054E-02

1

DISTRIBUTION OF CHEMICALS IN PPM AT 365.00 DAYS

0 Z = 0.00

	X									
Y	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	7.377	1.820	0.296	0.023	0.001	0.000	0.000	0.000	0.000	0.000
30.	2.131	1.172	0.225	0.018	0.001	0.000	0.000	0.000	0.000	0.000
61.	0.309	0.383	0.102	0.009	0.000	0.000	0.000	0.000	0.000	0.000
91.	0.050	0.083	0.029	0.003	0.000	0.000	0.000	0.000	0.000	0.000
122.	0.007	0.013	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000
152.	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
183.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
213.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
244.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
274.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

1

DISTRIBUTION OF CHEMICALS IN PPM AT 730.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	6.700	2.034	0.705	0.233	0.055	0.008	0.001	0.000	0.000	0.000
30.	2.024	1.400	0.583	0.202	0.049	0.007	0.001	0.000	0.000	0.000
61.	0.359	0.570	0.340	0.133	0.034	0.005	0.000	0.000	0.000	0.000
91.	0.085	0.184	0.150	0.068	0.019	0.003	0.000	0.000	0.000	0.000
122.	0.021	0.052	0.053	0.028	0.008	0.001	0.000	0.000	0.000	0.000
152.	0.005	0.013	0.015	0.009	0.003	0.000	0.000	0.000	0.000	0.000
183.	0.001	0.003	0.004	0.002	0.001	0.000	0.000	0.000	0.000	0.000
213.	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
244.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
274.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

1

DISTRIBUTION OF CHEMICALS IN PPM AT 1095.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	5.955	1.870	0.756	0.358	0.155	0.055	0.015	0.005	0.002	0.000
30.	1.812	1.303	0.637	0.318	0.142	0.050	0.013	0.005	0.001	0.000
61.	0.333	0.553	0.395	0.227	0.107	0.039	0.011	0.004	0.001	0.000
91.	0.085	0.194	0.194	0.132	0.068	0.026	0.007	0.003	0.001	0.000
122.	0.024	0.064	0.081	0.065	0.037	0.015	0.004	0.002	0.000	0.000
152.	0.007	0.020	0.030	0.027	0.017	0.007	0.002	0.001	0.000	0.000
183.	0.002	0.006	0.010	0.010	0.007	0.003	0.001	0.000	0.000	0.000
213.	0.001	0.002	0.003	0.003	0.002	0.001	0.000	0.000	0.000	0.000
244.	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
274.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

1

DISTRIBUTION OF CHEMICALS IN PPM AT 1460.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	5.288	1.671	0.703	0.372	0.203	0.103	0.045	0.023	0.011	0.001
30.	1.611	1.167	0.595	0.334	0.187	0.096	0.042	0.022	0.011	0.001
61.	0.298	0.500	0.376	0.244	0.146	0.078	0.035	0.018	0.009	0.001
91.	0.077	0.180	0.191	0.149	0.099	0.055	0.025	0.013	0.007	0.000
122.	0.022	0.061	0.084	0.079	0.058	0.034	0.016	0.009	0.004	0.000
152.	0.007	0.021	0.034	0.037	0.030	0.019	0.010	0.005	0.003	0.000
183.	0.002	0.007	0.013	0.016	0.014	0.009	0.005	0.003	0.001	0.000
213.	0.001	0.002	0.004	0.006	0.006	0.004	0.002	0.001	0.001	0.000
244.	0.000	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.000	0.000
274.	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000

1

DISTRIBUTION OF CHEMICALS IN PPM AT 1825.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	4.682	1.484	0.631	0.346	0.206	0.122	0.068	0.043	0.027	0.004
30.	1.428	1.037	0.535	0.312	0.191	0.115	0.064	0.041	0.025	0.004
61.	0.265	0.446	0.340	0.230	0.152	0.095	0.055	0.035	0.022	0.004
91.	0.069	0.161	0.175	0.143	0.105	0.070	0.041	0.027	0.017	0.003
122.	0.020	0.056	0.079	0.078	0.064	0.046	0.028	0.019	0.012	0.002
152.	0.006	0.019	0.033	0.038	0.035	0.027	0.018	0.012	0.008	0.001
183.	0.002	0.007	0.013	0.017	0.017	0.015	0.010	0.007	0.005	0.001
213.	0.001	0.002	0.005	0.007	0.008	0.007	0.005	0.004	0.002	0.000
244.	0.000	0.001	0.002	0.003	0.003	0.003	0.002	0.002	0.001	0.000
274.	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000

1

DISTRIBUTION OF CHEMICALS IN PPM AT 2190.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	4.145	1.315	0.561	0.312	0.192	0.122	0.077	0.055	0.039	0.010
30.	1.264	0.919	0.476	0.281	0.178	0.115	0.073	0.052	0.037	0.010
61.	0.235	0.396	0.303	0.208	0.142	0.096	0.062	0.045	0.032	0.009
91.	0.061	0.143	0.156	0.130	0.099	0.071	0.048	0.036	0.026	0.007
122.	0.018	0.050	0.071	0.072	0.062	0.048	0.034	0.026	0.019	0.005
152.	0.006	0.017	0.030	0.036	0.035	0.029	0.022	0.017	0.013	0.004
183.	0.002	0.006	0.012	0.016	0.018	0.016	0.013	0.011	0.008	0.003
213.	0.001	0.002	0.005	0.007	0.009	0.009	0.007	0.006	0.005	0.002
244.	0.000	0.001	0.002	0.003	0.004	0.004	0.004	0.003	0.003	0.001
274.	0.000	0.000	0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.000

1

DISTRIBUTION OF CHEMICALS IN PPM AT 2555.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	3.679	1.166	0.497	0.277	0.173	0.113	0.075	0.057	0.043	0.016
30.	1.122	0.815	0.422	0.250	0.160	0.107	0.072	0.054	0.041	0.016
61.	0.208	0.351	0.268	0.186	0.128	0.089	0.062	0.048	0.037	0.014
91.	0.054	0.127	0.139	0.117	0.090	0.067	0.048	0.038	0.030	0.012
122.	0.016	0.044	0.063	0.064	0.056	0.046	0.035	0.028	0.022	0.009
152.	0.005	0.015	0.026	0.032	0.032	0.028	0.023	0.019	0.016	0.007
183.	0.002	0.005	0.011	0.015	0.017	0.016	0.014	0.012	0.010	0.004
213.	0.001	0.002	0.004	0.007	0.008	0.009	0.008	0.007	0.006	0.003
244.	0.000	0.001	0.002	0.003	0.004	0.004	0.004	0.004	0.003	0.002
274.	0.000	0.000	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.001

1

DISTRIBUTION OF CHEMICALS IN PPM AT 2920.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	3.257	1.033	0.441	0.246	0.154	0.102	0.070	0.054	0.043	0.019
30.	0.993	0.722	0.374	0.222	0.143	0.096	0.066	0.052	0.041	0.019
61.	0.184	0.311	0.238	0.165	0.114	0.081	0.057	0.045	0.036	0.017
91.	0.048	0.113	0.123	0.104	0.080	0.061	0.045	0.037	0.030	0.014
122.	0.014	0.039	0.056	0.057	0.050	0.042	0.033	0.027	0.023	0.011
152.	0.004	0.014	0.023	0.029	0.029	0.026	0.022	0.019	0.016	0.008
183.	0.001	0.005	0.009	0.013	0.015	0.015	0.014	0.012	0.011	0.006
213.	0.000	0.002	0.004	0.006	0.007	0.008	0.008	0.007	0.007	0.004
244.	0.000	0.001	0.001	0.003	0.004	0.004	0.004	0.004	0.004	0.002
274.	0.000	0.000	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.001

1

DISTRIBUTION OF CHEMICALS IN PPM AT 3285.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	2.892	0.916	0.391	0.218	0.136	0.091	0.063	0.049	0.040	0.020
30.	0.882	0.640	0.332	0.197	0.127	0.086	0.060	0.047	0.038	0.019
61.	0.163	0.276	0.211	0.146	0.102	0.072	0.052	0.042	0.034	0.018
91.	0.043	0.100	0.109	0.092	0.072	0.054	0.041	0.034	0.028	0.015
122.	0.012	0.035	0.050	0.051	0.045	0.037	0.030	0.025	0.021	0.012
152.	0.004	0.012	0.021	0.025	0.026	0.023	0.020	0.017	0.015	0.009
183.	0.001	0.004	0.008	0.012	0.013	0.014	0.012	0.011	0.010	0.006
213.	0.000	0.001	0.003	0.005	0.007	0.007	0.007	0.007	0.006	0.004
244.	0.000	0.001	0.001	0.002	0.003	0.004	0.004	0.004	0.004	0.003
274.	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.002	0.002	0.002

1

DISTRIBUTION OF CHEMICALS IN PPM AT 3650.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	2.560	0.812	0.347	0.193	0.121	0.081	0.056	0.044	0.036	0.019
30.	0.781	0.568	0.294	0.174	0.112	0.076	0.053	0.042	0.035	0.019
61.	0.145	0.244	0.187	0.130	0.090	0.064	0.046	0.037	0.031	0.017
91.	0.038	0.089	0.097	0.081	0.063	0.048	0.037	0.030	0.025	0.015
122.	0.011	0.031	0.044	0.045	0.040	0.033	0.027	0.023	0.019	0.012
152.	0.003	0.011	0.018	0.023	0.023	0.021	0.018	0.016	0.014	0.009
183.	0.001	0.004	0.007	0.010	0.012	0.012	0.011	0.010	0.009	0.006
213.	0.000	0.001	0.003	0.005	0.006	0.007	0.007	0.006	0.006	0.004
244.	0.000	0.000	0.001	0.002	0.003	0.003	0.004	0.004	0.004	0.003
274.	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.002	0.002	0.002

1

DISTRIBUTION OF CHEMICALS IN PPM AT 4015.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	2.267	0.719	0.307	0.171	0.107	0.072	0.050	0.039	0.032	0.018
30.	0.691	0.503	0.261	0.155	0.100	0.067	0.047	0.038	0.031	0.017
61.	0.128	0.216	0.166	0.115	0.080	0.057	0.041	0.033	0.028	0.016
91.	0.033	0.078	0.086	0.072	0.056	0.043	0.032	0.027	0.023	0.013
122.	0.010	0.027	0.039	0.040	0.035	0.029	0.024	0.020	0.017	0.011
152.	0.003	0.009	0.016	0.020	0.020	0.018	0.016	0.014	0.013	0.008
183.	0.001	0.003	0.007	0.009	0.011	0.011	0.010	0.009	0.008	0.006
213.	0.000	0.001	0.003	0.004	0.005	0.006	0.006	0.006	0.005	0.004
244.	0.000	0.000	0.001	0.002	0.003	0.003	0.003	0.003	0.003	0.003
274.	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.002	0.002	0.002

1

DISTRIBUTION OF CHEMICALS IN PPM AT 4380.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	2.008	0.637	0.272	0.152	0.095	0.063	0.044	0.035	0.029	0.016
30.	0.613	0.445	0.231	0.137	0.088	0.060	0.042	0.034	0.027	0.015
61.	0.114	0.192	0.147	0.102	0.071	0.050	0.036	0.030	0.024	0.014
91.	0.030	0.069	0.076	0.064	0.050	0.038	0.029	0.024	0.020	0.012
122.	0.009	0.024	0.034	0.035	0.031	0.026	0.021	0.018	0.016	0.010
152.	0.003	0.008	0.015	0.018	0.018	0.016	0.014	0.013	0.011	0.008
183.	0.001	0.003	0.006	0.008	0.009	0.009	0.009	0.008	0.008	0.005
213.	0.000	0.001	0.002	0.004	0.005	0.005	0.005	0.005	0.005	0.004
244.	0.000	0.000	0.001	0.002	0.002	0.003	0.003	0.003	0.003	0.002
274.	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.002	0.002

1

DISTRIBUTION OF CHEMICALS IN PPM AT 4745.00 DAYS

0 Z = 0.00

Y \ X	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	1.777	0.565	0.241	0.135	0.084	0.056	0.039	0.031	0.025	0.014
30.	0.543	0.395	0.205	0.121	0.078	0.053	0.037	0.030	0.024	0.014
61.	0.101	0.170	0.130	0.090	0.063	0.045	0.032	0.026	0.022	0.013
91.	0.026	0.062	0.067	0.057	0.044	0.034	0.026	0.021	0.018	0.011
122.	0.008	0.021	0.031	0.031	0.028	0.023	0.019	0.016	0.014	0.009
152.	0.002	0.007	0.013	0.016	0.016	0.014	0.013	0.011	0.010	0.007
183.	0.001	0.003	0.005	0.007	0.008	0.008	0.008	0.007	0.007	0.005
213.	0.000	0.001	0.002	0.003	0.004	0.005	0.005	0.004	0.004	0.003
244.	0.000	0.000	0.001	0.001	0.002	0.002	0.003	0.003	0.003	0.002
274.	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001

1

DISTRIBUTION OF CHEMICALS IN PPM AT 5110.00 DAYS

0 Z = 0.00

	X								
Y	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	1.583	0.500	0.214	0.119	0.075	0.050	0.035	0.028	0.022	0.013
30.	0.482	0.350	0.181	0.108	0.069	0.047	0.033	0.026	0.022	0.012
61.	0.089	0.151	0.115	0.080	0.056	0.040	0.029	0.023	0.019	0.011
91.	0.023	0.055	0.060	0.050	0.039	0.030	0.023	0.019	0.016	0.010
122.	0.007	0.019	0.027	0.028	0.025	0.020	0.016	0.014	0.012	0.008
152.	0.002	0.007	0.011	0.014	0.014	0.013	0.011	0.010	0.009	0.006
183.	0.001	0.002	0.005	0.006	0.007	0.007	0.007	0.006	0.006	0.004
213.	0.000	0.001	0.002	0.003	0.004	0.004	0.004	0.004	0.004	0.003
244.	0.000	0.000	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002
274.	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001

0STEADY STATE SOLUTION HAS NOT BEEN REACHED BEFORE FINAL SIMULATING TIME

1

DISTRIBUTION OF CHEMICALS IN PPM AT 5475.00 DAYS

0 Z = . 0.00

	X								
Y	0.	152.	305.	457.	610.	762.	914.	1016.	1111.	1397.
0.	1.396	0.443	0.189	0.106	0.066	0.044	0.031	0.024	0.020	0.011
30.	0.426	0.310	0.161	0.095	0.061	0.042	0.029	0.023	0.019	0.011
61.	0.079	0.133	0.102	0.071	0.049	0.035	0.025	0.021	0.017	0.010
91.	0.021	0.048	0.053	0.045	0.035	0.026	0.020	0.017	0.014	0.009
122.	0.006	0.017	0.024	0.025	0.022	0.018	0.015	0.013	0.011	0.007
152.	0.002	0.006	0.010	0.012	0.012	0.011	0.010	0.009	0.008	0.005
183.	0.001	0.002	0.004	0.006	0.007	0.007	0.006	0.006	0.005	0.004
213.	0.000	0.001	0.002	0.003	0.003	0.004	0.004	0.004	0.003	0.003
244.	0.000	0.000	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002
274.	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001

PROJECT	COMP. BY	JOB NO.
Westover - EPCs for Cooley Brook	RAL	9904-03
	CHK. BY NSG	DATE 4/18/96

Metals/NO_3^-

After further review of the data, it has been decided that EPCs need to be calculated for the limited inorganics data (metals and nitrate). These additional calculations provide EPC estimates for these. Data available are from the GZA report for samples of 5/18 and 5/19/92 for Ca, Fe, Mn, Na, and NO_3. WMW-601 appears to be upgradient of the plumes, and a filtered sample from that well had 198 ppb Mn, and less than detection limits for sodium (<5000) and iron (<100).

To model concentration changes from the source areas to Cooley Brook, it was assumed that the metal contaminant distribution was the same as for the fuels, i.e., assuming Fe and Mn are due to increased metals concentrations as they act as electron donors during anaerobic biodegradation. Na may be due to road salting, and calcium and nitrate may be due to fertilizer applications, but similar source areas were assumed for these also. No retardation of the mobilized metals nor for the highly solubilized Na and NO_3^- was assumed from the source areas to Cooley Brook. K_ds from literature were taken for partitioning to sediments, with a K_d (no sufficient data available) for Ca taken as similar to that for Magnesium (67) and no partitioning for Na or NO_3^-.

K_ds taken are:

Ca	67
Fe	11
Mn	20
Na	0
NO_3^-	0

Maximums concentrations:

Data for both dissolved and unfiltered were reviewed, and the maximum of either set taken for evaluation. Values were:

	PH #1	PH #3	PH #6	DFA #2	
Ca	-	9500	12000	7400	
Fe	203	136000	32400	23500	Cmax at source
Mn	406	210	677	500	
Na	5580	8500	29800	5000	
NO_3^-	-	160	-	170	

Model dilution factors

DEA #2 $DF = \frac{5.028}{0.261} = 19.3$

[Taking maximum concentration at source divided by maximum concentration at receptor]

PH #1 $DF = \frac{5.564}{0.381} = 14.6$

PH #3 $DF = \frac{5.564}{0.346} = 16.1$

PH #6 $DF = \frac{5.564}{0.269} = 20.7$

Sediment partitioning

Calculate as before, using K_d in place of $f_{oc} \cdot K_{oc}$ as for the organic compounds.

Estimated maximum concentrations in sediments then range from

$C_p = \frac{C_w}{1 + \frac{1.33}{0.5} K_L}$ to C_w [pore water]

where $C_w = \frac{C_{max}}{DF}$

$C_{se} = C_p K_d$ to $C_{su} = C_w K_d \left[\text{Seds}\right]$

These are tabulated on the next page.

Surface water concentrations

Calculated as for the organic compounds, the estimated impact on surface water is:

$$\frac{C_{w,max}}{65} = C_{sw}$$

These values are also tabulated on the next page.

Recall these surface water concentrations are incremental per plume, and may be summed for total maximum impact (plume maximums may not arrive all at the same time). Also recall that Ca, Na and NO_3^- may not necessarily be attributable to fuel leaks.

Also realize that max Fe concs are generally unfiltered and dissolved concentrations are likely to be much lower (see comparison of MW-501 filtered/unfiltered for Fe).

PROJECT	COMP. BY	JOB NO.
Westover – EPCs for Cooley Brook	RAL	9904-03
	CHK. BY NSG	DATE 4/18/96

Tabulate calculations (all concs in ppb)

DFA #2

DF = 19.3

	C_{max}	C_w	C_p	C_{se}	C_{su}	C_{sw}
Ca	7400	383.4	2.14	143.4	25688	5.9
Fe	23500	1218	40.2	442	13398	18.7
Mn	500	25.9	0.5	9.6	518	0.4
Na	5000	259	259	–	–	4.0
NO_3^-	170	8.8	8.8	–	–	0.14

PH #1

DF = 14.6

	C_{max}	C_w	C_p	C_{se}	C_{su}	C_{sw}
Ca	–	–	–	–	–	–
Fe	203 *	13.9	0.46	5.1	153	0.21
Mn	406 *	27.8	0.51	10.2	556	0.43
Na	5580 *	382	382	–	–	5.9
NO_3^-	–	–	–	–	–	–

PH #3

DF = 16.1

	C_{max}	C_w	C_p	C_{se}	C_{su}	C_{sw}
Ca	9500	590	3.3	221	39530	9.1
Fe	136000	8447	279	3069	92917	130
Mn	210	13.0	0.24	4.8	260	0.2
Na	8500	528	528	–	–	8.1
NO_3^-	160	9.9	9.9	–	–	0.15

PH #6

DF = 20.7

	C_{max}	C_w	C_p	C_{se}	C_{su}	C_{sw}
Ca	12000	580	3.2	214	38860	8.9
Fe	32400	1565	51.7	569.	17215	24.1
Mn	677 *	32.7	0.60	12.1	654	0.50
Na	29800	1440	1440	–	–	22.2
NO_3^-	–	–	–	–	–	–

* Dissolved (filtered) concentrations; all others are total.

HUMAN HEALTH RISK CALCULATIONS FOR SURFACE WATER AND SEDIMENT

The revised MCP (1995) describes risk characterization methods (310 CMR 40.0941(3)) available for the determination of the need for remedial action or to demonstrate that a level of no significant risk of harm to health, public welfare, and the environment exists or has been achieved. There are currently three possible methods for characterizing risk to health, public welfare, and the environment per 310 CMR 40.0940 through 40.0996. These methods characterize risk through the use of promulgated standards (Method 1), promulgated standards supplemented by site-specific information (Method 2), or the application of site-specific risk assessment methodologies (Method 3).

For the risk evaluation at Westover Air Force Base, a Method 1/Method 2 Risk Characterization has been selected since the extent of contamination appears to involve primarily groundwater and soil. This assumption is based on (1) magnitude of contaminant concentrations modeled to reach surface water and sediment at Cooley Brook and (2) risk estimates calculated for potential childhood recreational exposures to media at Cooley Brook which may have been influenced by site activities.

Concentrations reaching Cooley Brook surface water and sediment from each study area have been modeled to characterize the nature and extent of contamination in those media. Tables 2 and 3 of Appendix D summarize the modeled concentrations for organic and inorganic contaminants, respectively, for each study area. For this evaluation, the maximum modeled concentration of each contaminant in sediment was used as the EPC for the most conservative approach. To provide the most conservative EPC for surface water, the sum of each plume's contribution to Cooley Brook was used. Inorganics that are essential human nutrients were not considered in the evaluation. Attachment E-1 documents the development of screening values for essential nutrients. Concentrations of calcium, iron, and sodium in surface water and sediment were all below screening values.

Potential childhood recreational exposure to contaminated media from Cooley Brook was the selected exposure scenario. Children were assumed to contact both surface water and sediment while wading through incidental ingestion of and dermal contact with both surface water and sediment. The theoretical receptor was assumed to engage in wading activities two times per week for seven months of the year (mid-April through mid-November), resulting in an exposure frequency of 56 days per year. Other exposure parameters used in this evaluation are shown on the risk calculation spreadsheets (Tables E-1 and E-2).

TABLE E-1
INGESTION OF AND DIRECT CONTACT WITH SURFACE WATER – MODELED CONCENTRATIONS
CHILD WADING, AGE 6-12
WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

WAFB-SW	04-Nov-96

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
Concentration in Surface Water	OHMsw	modeled	mg/liter	See Appendix B
Lifetime Average Daily Dose	LADD	calculated below		MADEP, 1995
Average Daily Dose	ADD	calculated below		MADEP, 1995
Ingestion Rate	IR	0.05	liters/day	MADEP, 1995
Surface Area Exposed	SA	3,221	cm^2	MADEP, 1995
Body Weight	BW	26	kg	MADEP, 1995
Conversion Factor 1	CF1	0.001	$liter/cm^3$	
Conversion Factor 2	CF2	24	hours/day	
Exposure Frequency	EF	56	days/year	Site-specific
Exposure Duration	ED	7	years	Site-specific
Averaging Time				
Cancer	ATc	75	years	MADEP, 1995
Noncancer	ATn	7	years	MADEP, 1995
Relative Absorption Factor (RAF)				
Oral	RAFo	listed below	unitless	MADEP, 1995
Dermal	RAFd	listed below	unitless	MADEP, 1995
Permeability Constant	Kp	listed below	cm/hour	MADEP, 1995

MADEP, 1995 "Guidance for Disposal Site Risk Characterization"

EQUATIONS

CANCER RISK = LADD (mg/kg-day) x CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$

HAZARD QUOTIENT = ADD (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{LADD-INGESTION} = \frac{\text{OHMsw x IR x RAFi x EF x ED}}{\text{BW x ATc x 365 days/yr}}$$

$$\text{ADD-INGESTION} = \frac{\text{OHMsw x IR x RAFi x EF x ED}}{\text{BW x ATn x 365 days/yr}}$$

$$\text{LADD-DERMAL} = \frac{\text{OHMsw x SA x Kp x RAFd x CF1 x CF2 x EF x ED}}{\text{BW x ATc x 365 days/yr}}$$

$$\text{ADD-DERMAL} = \frac{\text{OHMsw x SA x Kp x RAFd x CF1 x CF2 x EF x ED}}{\text{BW x ATn x 365 days/yr}}$$

Note:

CARCINOGENIC EFFECTS

OHM	WATER CONCENTRATION (mg/l)	ORAL RAF	INTAKE INGESTION (mg/kg-day)	Kp x RAFd (cm/hr)	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
VOLATILE ORGANICS									
Benzene	0.000103	1	2.6E-09	0.009	3.9E-08	2.9E-02	8.2E-11	1.1E-09	1.2E-09
Chloroform	0.0000006	1	1.7E-11	0.009	2.3E-10	6.1E-03	1.0E-13	1.4E-12	1.5E-12
						SUMMARY CANCER RISK	8E-11	1E-09	1E-09

NONCARCINOGENIC EFFECTS

OHM	WATER CONCENTRATION (mg/l)	ORAL RAF	INTAKE INGESTION (mg/kg-day)	Kp x RAFd (cm/hr)	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
VOLATILE ORGANICS									
Benzene	0.000103	1	3.0E-08	0.009	4.2E-07	3.0E-04	1.0E-04	1.4E-03	1.5E-03
Chloroform	0.0000006	1	1.8E-10	0.009	2.5E-09	1.0E-02	1.8E-08	2.5E-07	2.6E-07
Benzyl Alcohol	0.00000018	1	5.3E-11	0.033	2.7E-09	3.0E-01	1.8E-10	9.0E-09	9.2E-09
Xylenes	0.000012	1	3.5E-09	0.0048	2.6E-08	2.0E+00	1.8E-09	1.3E-08	1.5E-08
Carbon Disulfide	0.0000003	1	8.9E-11	0.001	1.4E-10	1.0E-01	8.9E-10	1.4E-09	2.3E-09
						SUMMARY HAZARD INDEX	1E-04	1E-03	2E-03

TABLE E-2
INGESTION OF AND DIRECT CONTACT WITH SEDIMENT -- MODELED CONCENTRATIONS
CHILD WADING, AGE 6-12
WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

WAFB-SD	04-Nov-96

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
Concentration in Sediment	OHMsd	modeled	mg/kg	See Appendix B
Lifetime Average Daily Dose	LADD	calculated below		MADEP, 1995
Average Daily Dose	ADD	calculated below		MADEP, 1995
Ingestion Rate	IR	50	mg/day	MADEP, 1995
Surface Area Exposed	SA	3,222	cm^2	MADEP, 1995
Body Weight	BW	31.6	kg	MADEP, 1995
Conversion Factor	CF	0.000001	kg/mg	
Exposure Frequency	EF	56	days/year	Site-specific
Exposure Period	EP	7	years	Site-specific
Averaging Time				
Cancer	ATc	75	years	MADEP, 1995
Noncancer	ATn	7	years	MADEP, 1995
Relative Absorption Factor (RAF)				
Oral	RAFo	listed below	unitless	MADEP, 1995
Dermal	RAFd	listed below	unitless	MADEP, 1995
Adherence Factor	AF	0.51	mg/cm^2	MADEP, 1995

MADEP, 1995 "Guidance for Disposal Site Risk Characterization"

EQUATIONS

CANCER RISK = LADD (mg/kg-day) x CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$

HAZARD QUOTIENT = ADD (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{LADD-INGESTION} = \frac{\text{OHMsd} \times \text{IR} \times \text{RAFo} \times \text{EF} \times \text{EP} \times \text{CF}}{\text{BW} \times \text{ATc} \times 365 \text{ days/yr}}$$

$$\text{ADD-INGESTION} = \frac{\text{OHMsd} \times \text{IR} \times \text{RAFo} \times \text{EF} \times \text{EP} \times \text{CF}}{\text{BW} \times \text{ATn} \times 365 \text{ days/yr}}$$

$$\text{LADD-DERMAL} = \frac{\text{OHMsd} \times \text{SA} \times \text{AF} \times \text{RAFd} \times \text{CF} \times \text{EF} \times \text{EP}}{\text{BW} \times \text{ATc} \times 365 \text{ days/yr}}$$

$$\text{ADD-DERMAL} = \frac{\text{OHMsd} \times \text{SA} \times \text{AF} \times \text{RAFd} \times \text{CF} \times \text{EF} \times \text{EP}}{\text{BW} \times \text{ATn} \times 365 \text{ days/yr}}$$

Note:
For noncarcinogenic risk, AT = EP

CARCINOGENIC EFFECTS

OHM	SEDIMENT CONCENTRATION (mg/kg)	RAFo	LADD INGESTION (mg/kg-day)	RAFd	LADD DERMAL (mg/kg-day)	CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Benzene	0.0043	1	9.7E-11	0.08	5.0E-10	2.9E-02	2.8E-12	1.5E-11	1.7E-11
Chloroform	0.000044	1	1.0E-12	0.1	6.4E-12	6.1E-03	6.1E-15	3.9E-14	4.5E-14
						SUMMARY CANCER RISK	3E-12	1E-11	2E-11

NONCARCINOGENIC EFFECTS

OHM	SEDIMENT CONCENTRATION (mg/kg)	RAFo	ADD INGESTION (mg/kg-day)	RAFd	ADD DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Benzene	0.0043	1	1.0E-09	0.08	5.4E-09	3.0E-04	3.5E-06	1.8E-05	2.1E-05
Chloroform	0.000044	1	1.1E-11	0.1	6.9E-11	1.0E-02	1.1E-09	6.9E-09	8.0E-09
Benzyl Alcohol	0.000013	1	3.2E-12	0.19	3.9E-11	3.0E-01	1.1E-11	1.3E-10	1.4E-10
Xylenes	0.00144	1	3.5E-10	0.12	2.7E-09	2.0E+00	1.7E-10	1.4E-09	1.5E-09
Carbon Disulfide	0.00003	0.99	7.2E-12	0.11	5.2E-11	1.0E-01	7.2E-11	5.2E-10	5.9E-10
Manganese	0.654	1.9	3.0E-07	0.14	1.4E-06	4.7E-02	6.4E-06	3.0E-05	3.7E-05
						SUMMARY HAZARD INDEX	1E-05	5E-05	6E-05

APPENDIX E

Toxicity values (i.e., slope factors and reference doses) used in this evaluation were obtained from IRIS (USEPA, 1996), HEAST (USEPA, 1995) or from the Environmental Criteria and Assessment Office (ECAO) of the USEPA and are shown on the calculation spreadsheets. Oral and dermal RAFs have been obtained from the "Risk Assessment Shortform Residential Exposure Scenario" (MADEP, 1992) and "Background Documentation for the Development of the MCP Numerical Standards (MADEP, 1994). Permeability constants were obtained from USEPA (1992).

The results of the quantitative risk evaluation are shown in Table E-3. Total carcinogenic risk associated with potential childhood exposures to surface water and sediment from Cooley Brook during wading is $1x10^{-9}$. This risk is more than one order of magnitude below the MADEP MCP target risk of $1x10^{-5}$. Noncarcinogenic risk associated with the same potential exposure is an HI of 0.001. This risk is also more than an order of magnitude below the MADEP MCP target HI of 1.

The evaluation indicates that the exposures for surface water and sediment are relatively minor and there is not a need to evaluate human health risks using Method 3. The Guidance for Disposal Site Risk Characterization (MADEP, 1995) indicates that if risks for media other than soil and groundwater are at least an order of magnitude below the MCP cumulative risk limits, it is not necessary to evaluate the whole site using Method 3.

TABLE E–3
SUMMARY OF HUMAN HEALTH RISK
FROM EXPOSURE TO SURFACE WATER AND SEDIMENT

WESTOVER AIR FORCE BASE
CHICOPEE, MASSACHUSETTS

COOLEY BROOK: CHILD WADING	MODELED CONCENTRATION	
Ingestion of Surface Water	7E–11	0.0001
Dermal Contact with Surface Water	1E–09	0.001
Ingestion of Sediment	3E–12	0.00001
Dermal Contact with Sediment	1E–11	5E–05
TOTAL	**1E–09**	**0.001**

References

Massachusetts Department of Environmental Protection (MADEP), 1992. *Risk Assessment Shortform Residential Exposure Scenario*; Office of Research and Standards and the Bureau of Waste Site Cleanup; Boston, Massachusetts; September 1992.

Massachusetts Department of Environmental Protection (MADEP), 1995. *Massachusetts Contingency Plan*; Office of Environmental Affairs; Boston, Massachusetts; February 1995.

U.S. Environmental Protection Agency (USEPA), 1992. *Dermal Exposure Assessment: Principles and Applications*; Office of Research and Development; EPA/600/8-91/011B; January 1992.

U.S. Environmental Protection Agency (USEPA), 1995. *Health Effects Assessment Summary Tables (HEAST)*; Office of Solid Waste and Emergency Response; Washington, DC; November 1995.

U.S. Environmental Protection Agency (USEPA), 1996. *Integrated Risk Information System (IRIS)*; Office of Health and Environmental Assessment; Environmental Criteria and Assessment Office; Cincinnati, Ohio; March 1996.

ATTACHMENT E-1

DERIVATION OF ESSENTIAL NUTRIENT SCREENING VALUES

Certain inorganics (calcium, iron, magnesium, potassium, and sodium) that are present as naturally occurring constituents in soil and groundwater, are required in limited intakes to maintain normal human physiological functions, and are therefore considered essential nutrients. The Risk Assessment Guidance for Superfund (RAGS), Volume I, Part A, regarding the treatment of essential nutrients in selection of Contaminants of Potential Concern (CPC), states that essential nutrients need not be quantitatively evaluated in a public health risk assessment if they are 1) present at low concentrations (consistent with background) and 2) toxic only at doses much higher than those which might be related to exposure at the site (USEPA, 1989). The focus of this Appendix is the technical approach for determining that an analyte is "toxic only at doses higher than those associated with exposures at the site" and a mechanism for making that determination by employing soil and groundwater screening concentrations. The screening concentrations are used to streamline the process and to eliminate the need to calculate essential nutrient doses as part of COC selection at every site. If the maximum concentration of an essential nutrient does not exceed the appropriate screening concentration shown below, the essential nutrient is considered non-toxic. Essential nutrients are not retained as COCs if they are detected at concentrations that are either consistent with background or do not exceed the screening concentrations.

Currently, no published essential nutrient screening concentrations for use in risk assessment COC selection are available. Therefore, surface soil and groundwater screening concentrations of essential nutrients have been derived that, when contacted in accordance with the exposure assumptions described below, are not expected to result in adverse health effects. The screening concentrations for groundwater and surface soil are presented in Table E-1-1. The essential nutrient concentrations in surface soil and groundwater are to be compared directly to the nutrient screening concentrations for the purposes of COC selection.

Table E-1-1
Essential Nutrient Screening Concentrations
for Surface Soil and Groundwater

Essential Nutrient	Surface Soil Screening Concentration (mg/kg)	Groundwater Screening Concentration (μg/L)
Calcium	1,000,000 [1]	1,055,398
Iron	47,824	13,267
Magnesium	460,468	118,807
Potassium	1,000,000 [1]	297,016
Sodium	1,000,000 [1]	396,022

[1] Actual calculated screening concentration is greater than 1,000,000 mg/kg (Table E-1-5), indicating that this essential nutrient would not be present at toxic levels in surface soil.

As described below, screening concentrations for surface soil and groundwater represent conservative screening concentrations for other media. These surface soil and groundwater screening concentrations are used to screen sediment and surface water, respectively.

DOCUMENTATION OF SURFACE SOIL AND GROUNDWATER SCREENING CONCENTRATIONS

The essential nutrient toxicity screening concentrations were derived in two steps: first, a "non-toxic" dose was identified for each essential nutrient; second, the soil and groundwater concentrations associated with the "non-toxic" doses were calculated using standard residential exposure assumptions. The details of the derivation of the screening values are presented below.

Identification of Non-Toxic Doses. The identification of doses which are not toxic is often accomplished by identifying Reference Doses (RfDs) which are published by USEPA. These RfDs represent doses, including a margin of safety, to which even sensitive subpopulations could be exposed for a lifetime without adverse non-carcinogenic effects. Because no RfDs for calcium, iron, magnesium, potassium, or sodium are available in the Integrated Risk Information System (IRIS) (USEPA, 1996) or the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1995), other published non-toxic doses

were sought out. Recommended Dietary Allowances (RDAs) prepared by the Food and Nutrition Board (FNB) of the National Research Council (NRC, 1989) have been selected here to represent non-toxic doses.

RDAs are defined by the FNB as "the levels of intake of essential nutrients that, on the basis of scientific knowledge, are judged by the Food and Nutrition Board to be adequate to meet the known nutrient needs of practically all healthy persons." It is assumed here, that since the RDA represents a requirement for good nutrition, that it also represents a dose which is non-toxic. Although some essential nutrients (arsenic for example) have been classified as carcinogens, none of the five nutrients discussed here have been classified as carcinogens. The available RDA data for calcium, iron, magnesium, potassium and sodium are presented in Table E-1-2. From this data set, RDAs for children were preferentially selected to coincide with the child exposure scenario. RDAs were converted from units of mg/day to units of mg/kg/day by dividing the RDA by the child resident body weight of 15 kg (USEPA, 1991). Dermal RDAs were developed by adjusting the oral RDA to compensate for the oral absorption efficiency in a manner similar to that presented in Appendix A of RAGS, Volume I, Part A (USEPA, 1989), and described in the human health risk assessment methodology of this document.

Calculation of Screening Concentrations. Risk-based screening concentrations for essential nutrients were derived by estimating concentrations in soil and groundwater that correspond to the RDAs for a residential exposure scenario. When the dose is equal to the RDA, the hazard quotient for the situation would equal one. Risk calculation spreadsheets have been used to assist in the calculation of the screening concentrations. When the concentration of an essential nutrient and the associated hazard quotient are known, only a simple calculation is needed to identify the concentration associated with a hazard quotient of one. An arbitrary nutrient concentration has been entered into risk spreadsheets to derive associated hazard quotient values as shown in Tables E-1-3 and E-1-4. Once that information was available, the equality shown below was used to calculate screening soil concentration with the target hazard quotient equal to one.

Screening groundwater concentrations were calculated in a similar manner. The baseline groundwater concentration is arbitrary and is used only to establish a baseline hazard quotient to solve the equality. To derive screening concentrations that would be protective to the majority of the exposed population, the exposure assumptions for a child resident

Table E-1-2

Recommended Dietary Allowances [1]

Nutrient	RDA	Age (years)	Oral Absorption (%)	Typical dietary intake (mg/day)	Toxicity Threshold (mg/day)	Oral RDA (mg/kg/day) [2]	Dermal RDA (mg/kg/day) [3]
Calcium	800 (mg/day)	1-10	40	743 (average of all ages)	NA	53.3	21.2
	1200 (mg/day)	11-24		1179	NA		
	800 (mg/day)	>24		743 (average of all ages); 530 (women ages 35-50)	>2500		
Iron	10 (mg/day)	1-20	10-15	10-15	25-75 (NOAEL); 3000 (lethal)	0.67	0.067
	15 (mg/day)	>20		10-15	25-75 (NOAEL); 14000 (lethal)		
Magnesium	6 (mg/kg/day)	1-15	50	193 (age 1-5)	NA	6	3
	4.5 (mg/kg/day)	>15		207-329	NA		
Potassium	15-20 (mg/kg/day)	1-10	90	1500	NA	15	13.5
	1600-2000 (mg/day)	>20		2500	18000 (hyperkalemia)		
Sodium	300 (mg/day)	2-5	90 [4]	NA	NA	20	18
	500 (mg/day)	Adult		1800-5000	2400 (intake not to be exceeded)		

Notes:

[1] All data from NRC (1989).

[2] Adjusted oral RDA calculated by dividing the RDA (mg/kg) by the bodyweight of a child ages 1-6 (15 kg) (USEPA, 1991); RDAs provided in mg/kg/day were not modified.

[3] Adjusted dermal RDA calculated by multiplying the oral RDA by the oral absorption efficiency (USEPA, 1989).

[4] Oral absorption data not available; value for potassium used as a surrogate based on physio-chemical similarities.

were used. For groundwater, screening concentrations were based on ingestion of groundwater as drinking water. For surface soil, screening concentrations were based on ingestion of surface soil and dermal contact with surface soil. Child resident exposure to surface soil and groundwater used as drinking water is usually greater than or equal to oral and dermal exposure to media treated as soil and groundwater, respectively, for exposure assessment. Therefore, screening values for surface soil represent conservative screening values for sediment, and screening values for groundwater used as drinking water represent conservative screening values for surface water. The exposure parameters for the child resident are presented the accompanying surface soil and groundwater screening concentration spreadsheets (Tables E-1-3 and E-1-4, respectively).

The calculated essential nutrient screening concentrations for surface soil and groundwater are presented in Table E-1-5. These values represent the concentrations of individual essential nutrients in media that, if contacted in accordance with the exposure parameters used to derive the screening concentration, would theoretically result in the receptor receiving their recommended dietary allowance of an essential nutrient solely from the contacted media. For some nutrients, the calculated screening concentrations exceed one million mg/kg (i.e., 100%). Such concentrations indicate that no concentration of nutrient in the particular media would result in an intake that exceeds the RDA, given the exposure assumptions on which the screening value is based. Because these screening concentrations do not take into account the additivity of exposures between media (and other dietary intakes, including food), a receptor exposed to essential nutrients that are present in multiple media at the screening concentrations would, in essence, be receiving more than their recommended dietary allowance of nutrient. However, data provided in Table E-1-2 indicate that the toxicity threshold for most essential nutrients is several times greater than the RDA; the RDA is not a toxicity threshold value. Therefore, these screening concentrations do not represent concentrations which, if exceeded, would necessarily result in deleterious effects.

TABLE E-1-3
DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL - ESSENTIAL NUTRIENTS
CHILD RESIDENT

SS-NUTR	04-Nov-96

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	chemical-specific	
INGESTION RATE	IR	200	mg/day	USEPA, 1991
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm²-event	USEPA, 1992a
AGE-SPECIFIC SURFACE AREA	SA_i	age-specific	cm²	USEPA, 1989
ABSORPTION FRACTION	ABS_d	chemical specific	unitless	USEPA, 1992b
CONVERSION FACTOR	CF	1.00E-06	kg/mg	SEE BELOW
BODY WEIGHT	BW	15	kg	USEPA, 1991
AGE-SPECIFIC BODY WEIGHT	BW_i	age-specific	kg	USEPA, 1989
EXPOSURE FREQUENCY	EF	350	days/year *	USEPA, 1991
EXPOSURE DURATION	ED	6	years	USEPA, 1991
AGE-SPECIFIC EXPOSURE DURATION	ED_i	age-specific	years	Assumption
AGE-WEIGHTED SURFACE AREA [1]	$SA_{soil/adj}$	766	cm2-year/kg	Per USEPA, 1992a
DOSE ABSORBED PER EVENT	DA_{event}	chemical specific	mg/cm²-event	Per USEPA, 1992a
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	6	years	USEPA, 1991

* Units for exposure frequency are in events/year in the calculation of the dermally absorbed dose.
[1] In estimating the dermally absorbed dose for children age 1 through 6, the time-weighted, bodyweight normalized surface area exposed is calculated from surface area, exposure duration, and body weight for each of 6 age periods, age 1 through 6, per USEPA, 1992.
USEPA, 1989. Exposure Factors Handbook;EPA/600/8-89/043; May 1989.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA, 1992a. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992 and Dermal Exposure Appendix of this document.
USEPA, 1992b. USEPA Region IV Guidance Memo February 10, 1992.
CF = 10E-09 kg/ug for organics

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RECOMMEDED DIETARY ALLOWANCE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = (DA_{event} \times EF / AT \times 365\ days/year) \times SA_{soil/adj}$$

Where:

$$SA_{soil/adj} = SUM\ (SA_i \times ED_i / BW_i)$$
$$DA_{event} = CS \times AF \times ABS_d \times CF$$

Note:
For noncarcinogenic effects: AT = ED

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL CSF (mg/kg-day)^-1	CANCER RISK INGESTION	DERMAL ABS	INTAKE DERMAL (mg/kg-day)	DERMAL CSF (mg/kg-day)^-1	CANCER RISK DERMAL	TOTAL CANCER RISK
[1] Essential nutrients are not considered carcinogenic from exposure through the oral or dermal routes.											
					SUMMARY CANCER RISK	0.0E+00				0E+00	0E+00

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL RDA (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL ABS [1]	INTAKE DERMAL (mg/kg-day)	DERMAL RDA [2] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Calcium	I	5000	mg/kg	6.4E-02	5.3E+01	1.2E-03	0.001	6.1E-04	2.1E+01	2.9E-05	1.2E-03
Iron	I	5000	mg/kg	6.4E-02	6.7E-01	9.5E-02	0.001	6.1E-04	6.7E-02	9.1E-03	1.0E-01
Magnesium	I	5000	mg/kg	6.4E-02	6.0E+00	1.1E-02	0.001	6.1E-04	3.0E+00	2.0E-04	1.1E-02
Potassium	I	5000	mg/kg	6.4E-02	1.5E+01	4.3E-03	0.001	6.1E-04	1.4E+01	4.5E-05	4.3E-03
Sodium	I	5000	mg/kg	6.4E-02	2.0E+01	3.2E-03	0.001	6.1E-04	1.8E+01	3.4E-05	3.2E-03
					SUMMARY HAZARD INDEX	1.1E-01				9E-03	1E-01

TABLE E-1-4
INGESTION OF GROUNDWATER AS DRINKING WATER (UNFILTERED SAMPLES) - ESSENTIAL NUTRIENTS
CHILD RESIDENT

GW-NUTR	04-Nov-96

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION WATER	CW	chemical specific	ug/liter	
INGESTION RATE	IR	0.79	liters/day	USEPA, 1989
BODY WEIGHT	BW	15	kg	USEPA, 1991
CONVERSION FACTOR	CR	0.001	mg/ug	
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1991
EXPOSURE DURATION	ED	6	years	USEPA, 1991
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	6	years	USEPA, 1991

USEPA, 1989. Exposure Factors Handbook, Final Report, EPA/600/8-89/043, May 1989.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors", OSWER Directive 9285.6-03.

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / RECOMMENDED DIETARY ALLOWANCE (mg/kg-day)

$$INTAKE_{ing} = \frac{CW \times IR \times EF \times ED \times CF}{BW \times AT \times 365\ days/year}$$

NOTE:
For noncarcinogenic effects AT = ED

CARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION
[1] Essential nutrients are not considered carcinogenic from exposure through the oral route.					
TOTAL CANCER RISK					0E+00

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	RECOMMENDED DIETARY ALLOWANCE (mg/kg-day)	HAZARD QUOTIENT INGESTION
Calcium	5000	ug/liter	2.5E-01	5.3E+01	4.7E-03
Iron	5000	ug/liter	2.5E-01	6.7E-01	3.8E-01
Magnesium	5000	ug/liter	2.5E-01	6.0E+00	4.2E-02
Potassium	5000	ug/liter	2.5E-01	1.5E+01	1.7E-02
Sodium	5000	ug/liter	2.5E-01	2.0E+01	1.3E-02
TOTAL HAZARD INDEX					5E-01

Table E-1-5

Theoretical Essential Nutrient Screening Concentrations for Surface Soil and Groundwater

Essential Nutrient	Surface Soil Screening Concentration (mg/kg) [1]	Groundwater Screening Concentration (μg/L) [2]
Calcium	4,070,824 [3]	1,055,398
Iron	47,824	13,267
Magnesium	460,468	118,807
Potassium	1,160,864 [3]	297,016
Sodium	1,547,819 [3]	396,022

Notes:

[1] Surface soil screening concentrations calculated as described in text, using RDAs presented in Table E-1-2 and the exposure parameters and risk calculations presented in Table E-1-3.

[2] Groundwater screening concentrations calculated as described in text, using RDAs presented in Table E-1-2 and the exposure parameters and risk calculations presented in Table E-1-4.

[3] The calculation of a screening concentration larger than 1,000,000 mg/kg indicates that no concentration results in an intake greater than the RDA, given the standard exposure parameters.

References

National Research Council (NRC), 1989. *Recommended Dietary Allowances, Tenth Edition.* National Research Council Subcommittee on the Tenth Edition of the RDAs, Food and Nutrition Board Commission on Life Sciences. National Academy of Sciences. National Academy Press, Washington, D.C.

USEPA, 1989. *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part A).* U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C., December. EPA/540/1-89/002.

USEPA, 1991. *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors*. OSWER Directive 9285.6-03.

USEPA, 1996. Integrated Risk Information System (IRIS). Online. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH.

USEPA, 1995. *Health Effects Assessment Summary Tables: FY-1994 Annual.* U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., March, 1994. EPA 540-R-94-020.

DERIVATION OF METHOD 1 GW-3 STANDARDS FOR METHOD 2 RISK ASSESSMENT

DERIVATION OF METHOD 1 GW-3 STANDARDS FOR METHOD 2 RISK ASSESSMENT

This section describes the technical approach used to develop MCP Method 1 Category GW-3 standards. As described in Subsection 2.7, MCP Method 2 Groundwater and Soil standards are developed for contaminants for which MCP Method 1 standards have not been promulgated per 310 CMR 40.0983, 310 CMR 40.0984, and 310 CMR 40.0985. Groundwater contaminants evaluated in this Method 2 Risk Characterization for which no GW-3 standards have been promulgated include dibenzofuran, benzyl alcohol, 2-methylphenol, 4-methylphenol, iron and manganese. The derivation of GW-3 standards for these analytes is presented below. The MCP Category GW-3 standards are intended to provide protection for ecological receptors against the migration and eventual discharge of groundwater contaminants to surface water bodies where ecological receptors reside. The Method 1 GW-3 Standards are derived using the lowest ecologically-based Water Quality Criterion (WQC) available for those analytes for which no water quality criterion have previously been established (310 CMR 40.0983[4a]). For iron, a national Ambient Water Quality Criterion (AWQC) of 1000 μg/L is available, and is used as the basis for the GW-3 standard for this risk characterization (as described below, this standard is adjusted by a dilution factor of 10, resulting in a GW-3 standard of 10,000 μg/L). Therefore, development of a GW-3 standard for iron is not presented in this Appendix.

Two types of WQC are normally derived: an average concentration called the criterion continuous concentration (CCC), and a maximum concentration called the criterion maximum concentration (CMC). The CCC is intended to be protective for chronic effects to aquatic organisms and bioaccumulation by aquatic organisms following long-term exposures, whereas the CMC is intended to be protective for acute effects to aquatic organisms following episodic short-term exposures. The lower of the CCC or CMC is selected as the basis of the Method 1 GW-3 groundwater standard.

Derivation of CMC and CCC was based on the approach used to develop national Ambient Water Quality Criteria (AWQC), as described in USEPA (1985). In summary, this methodology requires specific aquatic toxicity data which are used to develop genus mean acute values, culminating in calculation of a final acute value (FAV) and a final chronic value (FCV). The required data include aquatic toxicity data for eight different taxonomic families. All data used must be from a toxicity study which was conducted using acceptable test procedures as outlined in USEPA (1985). If insufficient data are available to derive a FAV or FCV, a fish genus or species mean acute value (SMAV) may be used as the CCC or CMC. To develop the SMAV, acceptable data from at least two studies which assess the same commercially or recreationally important fish species and toxicity endpoint are used; the SMAV is the geometric mean of the endpoint values reported. If sufficient data are unavailable to develop a SMAV, the lowest observable adverse effect level (LOAEL) reported among all species is used for the CMC. In

addition, if the lowest LOAEL value reported among all acceptable studies is below the SMAV, then the LOAEL value is selected as the CMC.

In order to develop CCC and CMC for the five contaminants requiring derivation of GW-3 standards, available aquatic toxicity information was obtained from the USEPA Aquatic Information Retrieval (AQUIRE) database. The AQUIRE database output for each contaminant was reviewed and data appropriate for GW-3 standard development were identified. AQUIRE database records involving any of the following records were not utilized in developing GW-3 standards.

- The study reliability (as defined in the AQUIRE manual [CIS, 1991]) was either a 3 or 4 (studies assigned these ratings do not meet USEPA [1985] guidelines for acceptable study methodology)
- Test organisms were salt water species
- Protozoans were the test organisms employed in the study
- The study endpoint was either not reported, or was not appropriate for developing acute or chronic values.
- The units of contaminant reported in the study were not suitable for CCC or CMC derivation (e.g., mg/kg [dose], l/ha [application rate]).

The results of the AQUIRE database search for the five analytes are discussed below.

In general, suitable acute toxicity data were available to derive a CMC for each analyte. However, data were not available to derive FAVs, and few data were available to derive SMAVs. Therefore, CMCs were generally based on the lowest LOAEL reported among all acceptable studies for a given analyte. In addition, suitable chronic data were generally not available. Therefore, a structure-activity relationship data base for aquatic toxicity data, ECOSAR, was used to develop CCC values. ECOSAR is a structure-activity relationship (SAR) program developed by USEPA, which was used to predict the aquatic toxicity of chemicals based on their structural similarity to chemicals for which aquatic toxicities have previously been measured. ECOSAR estimates toxicity values for chemicals lacking measured toxicity data using regression equations and the chemical/physical data for the chemical of interest.

According to the MCP, the lower of the CCC or CMC should be selected for the basis of the GW-3 standard. The GW-3 standard is developed by multiplying this value by a factor of 10 to account for dilution and attenuation.

Dibenzofuran. Results for 22 different aquatic toxicity tests for dibenzofuran were obtained from the AQUIRE database. The majority of reported results are based on acute toxicity tests, although a data for a few chronic exposures are available. Only 13 of the 22 studies were retained following a review of the identified criteria. Eight test results were rejected because they did not meet the minimum study quality criteria. In addition, one test was rejected because insufficient detail regarding the measured endpoint was provided.

Table F-1 presents a summary the 13 test results that meet evaluation guidelines. Acute toxicological data are available for 4 taxonomic groups, including sheepshead minnow (5 studies), water flea (4 studies), fathead minnow (2 studies), and guppy (2 studies). LC_{50} values for these studies range from 1,340 μg/L (water flea) to 18,000 μg/L (guppy). One no observable effect concentration (NOEC) of 1,000 μg/L is available for the sheepshead minnow. These water flea and fish LC_{50}s are comparable to the LC_{50}s estimated by the ECOSAR. The ECOSAR output is appended to Table F-1.

A FAV could not be calculated for dibenzofuran because the required toxicity data for 8 taxonomic groups were not available. No SMAVs were determined for dibenzofuran because none of the species for which there are toxicity data are considered commercially or recreationally important. Therefore, the LOAEL among all suitable data was selected as the CMC. For dibenzofuran, this value is 1,340 μg/L, based on the 48-hour LC_{50} for the water flea (*Daphnia magna*). This value is comparable to the estimated ECOSAR 48-hour LC_{50} for daphnid (1,657 μg/L).

No suitable chronic data are available for dibenzofuran. Therefore, the CCC was based on the ECOSAR predicted 16-day chronic value for daphnids (213 μg/L). In accordance with MCP GW-3 standard derivation methodology, the GW-3 standard was based on the lesser of the CMC or CCC, multiplied by a dilution factor of 10. As indicated in Table F-1, the GW-3 standard for dibenzofuran is 2,130 μg/L.

Benzyl alcohol. Results for 30 different aquatic toxicity tests for benzyl alcohol were obtained from the AQUIRE database. All of the reported results are based on acute toxicity tests, with the exception of 3 studies for which no test duration information are available. Of the 30 tests, only 10 studies were retained using the selection criteria listed above. Twelve test results were rejected because they did not meet the minimum study quality criteria. Eight additional tests were rejected because the units were reported as an application rate (e.g., l/ha), rather than a chemical concentration.

Table F-2 presents a summary of the 10 test results that meet evaluation guidelines. Acute toxicological data are available for 4 taxonomic groups, including bluegill (1 study), water flea (3 studies), fathead minnow (5 studies), and inland silverside (1 studies). All test results using fish species are reported as various acute duration LC_{50} values, and range from 10,000 μg/L (bluegill) to 770,000 μg/L (fathead minnow). The

three water flea test results are reported as 24-hour effect-concentration (EC) data, and range from 26,000 μg/L (EC_0) to 100,000 μg/L (EC_{100}). These toxicity test results are comparable with those estimated using ECOSAR. The ECOSAR output is appended to Table F-2. The ECOSAR 96-hour fish LC_{50} is 563,136 μg/L, and the estimated daphnid 16-day EC_{50} and 48-hour LC_{50} values bracket the measured EC values.

An FAV could not be calculated for benzyl alcohol because the required toxicity data for 8 taxonomic groups were not available. No species mean acute values were determined for benzyl alcohol because there is only one study available for commercially- or recreationally-important species. Therefore, the LOAEL value for among all suitable studies was selected as the CMC. For benzyl alcohol, this value is 10,000 μg/L, based on the 96-hour LC_{50} for the bluegill. This value is less than the predicted ECOSAR 96-hour fish LC_{50} (563,156 μg/L).

No suitable chronic data are available for benzyl alcohol. Therefore, the CCC is based on the ECOSAR predicted 16-day chronic value for daphnids (19,617 μg/L). In accordance with MCP GW-3 standard derivation methodology, the GW-3 standard was based on the lesser of the CMC or CCC, multiplied by a dilution factor of 10. As indicated in Table F-2, the GW-3 standard for benzyl alcohol is 100,000 μg/L.

2-Methylphenol. Results for 86 different aquatic toxicity tests were obtained from the AQUIRE database for 2-methylphenol. The majority of reported results are based on acute toxicity tests although a few data for chronic exposure are available. Fifty-one of the 86 studies were retained following a review of the identified criteria. Twenty-three test results were rejected because they did not meet the minimum study quality criteria. Eleven studies were rejected because they were based on tests for protozoans or salt water species. An additional study was rejected because the units were reported as a chemical dose (e.g., mmol/kg).

Table F-3 presents a summary of the 51 test results that meet evaluation guidelines. Acute toxicological data are available for a number of taxonomically diverse organisms including fish (21), insects (7), other invertebrates (17), algae (9), and amphibians (2). Various acute duration LC_{50} values for fish species range between 8,400 μg/L (rainbow trout) and 66,800 μg/L (channel catfish). These results are comparable with the ECOSAR predicted 96-hour fish LC_{50} of 16,158 μg/L. The measured 48-hour LC_{50} for the water flea (*daphnia magna*) of 5,000 μg/L is also comparable with the ECOSAR predicted 48-hour LC_{50} of 5,921 μg/L. The ECOSAR output is appended to Table F-3. Acute LC_{50}s for other species range from 10,000 μg/L (stonefly) to 1,600,000 μg/L (Great pond snail).

Species mean acute values were calculated for three fish species, including channel catfish, rainbow trout, and bluegill. These SMAVs range from 10,450 μg/L (rainbow trout) to 27,353 μg/L (channel catfish). These SMAVs are comparable with the ECOSAR predicted 96-hour fish LC_{50} of 16,158 μg/L. Although SMAVs for these three fish species were calculated, the lowest LOAEL of 5,000 μg/L (based on the 48-hour LC_{50} for the water flea) is less than these SMAVs. Therefore, the LOAEL was selected as the CMC value. As stated above, this value is comparable with the ECOSAR predicted daphnid LC_{50}.

No suitable chronic data are available for 2-methylphenol. Therefore, the CCC was based on the ECOSAR predicted 60-day chronic value for fish (131 μg/L). In accordance with MCP GW-3 standard derivation methodology, the GW-3 standard was based on the lesser of the CMC or CCC, multiplied by a dilution factor of 10. As indicated in Table F-3, the GW-3 standard for benzyl alcohol is 1,310 μg/L.

4-Methylphenol. Results for 46 different aquatic toxicity tests for 4-methylphenol were obtained from the AQUIRE database. All of the reported results are based on acute toxicity tests, with the exception of 4 chronic duration studies. Of the 46 tests, one-half of the studies were retained based on the selection criteria listed above. Fourteen test results were rejected because they did not meet the minimum study quality criteria. Four studies were rejected because they were based on tests for protozoans or salt water species. An additional five studies were rejected because the units were reported as a chemical dose (e.g., mmol/kg).

Table F-4 presents a summary of the 22 test results that meet evaluation guidelines. Acute toxicological data are available for 5 taxonomic groups, including green alga (3 studies), water flea (8 studies), fathead minnow (8 studies), turbellarian (1 study), and rainbow trout (2 studies). In addition, a population test result was reported for "miscellaneous" invertebrates. With the exception of two fathead minnow test results, all data using fish species are reported as various acute duration LC_{50} values, and range from 7,500 μg/L (rainbow trout) to >30,000 μg/L (fathead minnow). The fish toxicity test results are comparable with those estimated using ECOSAR, with a predicted 96-hour LC_{50} of 18,621 μg/L. The ECOSAR output is appended to Table F-4.

An FAV could not be calculated for 4-methylphenol because the required toxicity data for 8 taxonomic groups were not available. However, a SMAV was calculated for rainbow trout (a recreationally important species) because two 96-hour LC_{50} studies for this species were available for 4-methylphenol. This value is less than the predicted ECOSAR acute 96-hour fish LC_{50} (18,621 μg/L). However, the SMAV (7,700 μg/L) is greater than the lowest LOAEL of 1,400 μg/L for the water flea. This LOAEL is based on a 48-hour LC_{50} value, and is less than the ECOSAR predicted daphnid 48-hour LC_{50} value (6,506 μg/L). Therefore, the CMC value is based on the LOAEL of 1,400 μg/L.

No suitable chronic data are available for 4-methylphenol. Therefore, the CCC was based on the ECOSAR predicted 60-day chronic value for fish (146 μg/L). In accordance with MCP GW-3 standard derivation methodology, the GW-3 standard was based on the lesser of the CMC or CCC, multiplied by a dilution factor of 10. As indicated in Table F-4, the GW-3 standard for 4-methylphenol is 1,460 μg/L.

Manganese. Results for 82 different aquatic toxicity tests for manganese were obtained from the AQUIRE database. However, only 4 studies were retained based on the selection criteria listed above. Forty-five test results were rejected because they did not meet the minimum study quality criteria. An additional 33 studies were rejected based on the endpoint evaluated, which was bioconcentration factor (BCF); this value is not applicable for CMC derivation.

Table F-5 presents a summary of the 4 test results that meet evaluation guidelines. Acute toxicological data are available for 4 taxonomic groups, including blue-green alga (1 study), duckweed (1 study), flagellate euglenoid (1 study), and phytoplankton (1 study). The phytoplankton study is a chronic duration 38-day study which evaluated population growth (280 μg/L). The duckweed study reported the 4-day EC_{50} (31,000 μg/L), whereas the algal studies evaluated biochemical endpoints. No data for manganese are available in ECOSAR.

An FAV could not be calculated for manganese because the required toxicity data for 8 taxonomic groups were not available. Likewise, since there were no fish studies available, a SMAV was not calculated. Therefore, the acute LOAEL value of 550 μg/L for enzyme effects in flagellate euglenoid was chosen as the CMC.

The only chronic value available for manganese is for phytoplankton; no data were available in ECOSAR. The measured chronic value is 280 μg/L, based on a 38-day population growth study in phytoplankton. In accordance with MCP GW-3 standard derivation methodology, the GW-3 standard was based on the lesser of the CMC or CCC, multiplied by a dilution factor of 10. As indicated in Table F-5, the GW-3 standard for manganese is 2,800 μg/L.

Derivation of a Method 2, GW-3 Standard for Iron

A GW-3 Standard was derived for iron using Method 2. As stated on page 6-2 of the Risk Characterization Guidance (MADEP, 1995), the risk assessor may both develop a new standard for a chemical lacking a Method 1 standard *and* adjust the fate and transport aspects of that new standard to address site-specific conditions.

To derive the Method 2, GW-3 Standard for iron, a site-specific dilution factor was derived based on information presented in Appendix D of the report. In that appendix, a model is used to estimate surface water concentrations (Csw) based on the maximum groundwater concentration at each of the 4 areas (DFA #2, PH #1, PH #3, and PH #6). A site-specific dilution factor was derived by determining the ratio of the groundwater concentration to the resulting surface water concentration. This factor replaces the standard conservative 10-fold dilution factor used to develop the Method 1 GW-3 Standards.

Former Storage Area	Maximum Groundwater Conc (ug/L)	Predicted Surface Water Conc (ug/L)	Dilution Factor (GW/SW)
DFA #2	23,500	18.7	1257
PH #1	203*	0.21	967
PH #3	136,000	130	1045
PH #6	32,400	24.1	1344

* Dissolved (filtered) concentration; all others total.

By applying the lowest (most conservative/protective) dilution factor of 967 to the federal Ambient Water Quality Criterion for protection of aquatic life of 1,000 ug/L (USEPA, 1986), a Method 2, GW-3 standard of 967,000 ug/L is derived for iron.